A MONOGRAPH

ON

IRON AND STEEL WORK

IN THE PROVINCE OF BENGAL.

BY

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PREFACE.

THIS Monograph has been prepared in accordance with the orders of Government, contained in Miscellaneous Circular No. 5 of the Revenue, Political and Appointment Department, dated Calcutta, 9th March 1907.

These orders directed that the Monograph should be confined to indigenous manufactures. It is easy to show that the art of working in iron and steel in Bengal has from very remote times been indebted to the outside world for assistance, not only by ideas but by actual supervision and control of the workers by foreign experts, so that it becomes almost a question whether any part of the industry can be called indigenous. I have, however, taken the orders to mean that the work of large engineering firms, conducted under European supervision, should be excluded from the Monograph; and in consequence I have given only such a brief account of such firms as is absolutely essential for a properly proportioned sketch of the whole industry and for a discussion of its future prospects.

A MONOGRAPH ON IRON AND STEEL WORK

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CHAPTER I.

HISTORY OF THE SUBJECT.

B.C. 1400 to B.C. 150.

As is well known, the general history of India before the Christian era, or indeed before the Muhammadan conquest of this country, is practically unrecorded, and we are almost entirely dependent for any knowledge of these earlier periods on the *Vedas*, on *Manu's Code*, and later on the *Puranas*. Archæological investigations have also been of some use in supplementing the knowledge gained from these books.

The *Vedas* are undoubtedly the first records available. Whilst the date or dates of their production is to some extent uncertain, we may for our purposes assume that they were written about the 14th century B.C. These books contain several interesting references to iron and steel and to weapons. The *Vedas* must of course be taken to refer to the whole of the country of the Hindus, and the present Province of Bengal will be included. The chief weapons referred to are the bow and arrow (Wilson's *Rig Veda* IV, 26), swords (*loc cit.* II, 156), spears (*loc cit.* IV, 25), javelins (*loc cit.* II, 292), lances (*loc cit.* I, 174), hatchets (*loc cit.* I, 120) and the discus (*loc cit.* III, 35); and the references to the protective coat-of-mail are very numerous (*loc cit.* II, 66; II, 310; IV, 23; IV, 27; IV, 80). That the weapons above enumerated were made of iron is also stated (*loc cit.* I, 226, and IV, 27—the latter reference being to the arrow in particular and the former to weapons in general). They are further mentioned as being whetted on a grindstone (*loc cit.* II, 33 and II, 310), and polished to enhance their brightness (*loc cit.* II, 326). According to Babu Rajendralal Mitra (Antiquities of Orissa), there is also a reference in the *Rig Veda* to the use of razors, which would be absolutely useless unless made of steel. There is a reference in the *Satarudrya* hymn of the *Vajasaneyi Sanhita* of the *Vajur Veda* which shows that coat-of-mail was made of *iron* (Muir's Sanskrit Texts IV, p. 270). In the *Dhanurveda*, which is a subsidiary *Veda*, containing only the rules regarding archery, there is reference to a special arrow, termed the *Náráchá*, of which the peculiarity was its construction entirely of iron, whilst of the ordinary arrow only the head or blade was of this metal. In the *Brhat Sañhitá of Varáha Mihria* (Chap. IV, which will be found translated by Kern in the Journal R. As. Soc. N. S. VI, pp. 81 *et. seq.*) there is given a most detailed and interesting account of the tempering of swords, which shows that even at this period steel was distinguished from iron, and the nicety of this process of tempering was appreciated, as it was known that very small alterations in the details of the process would materially affect the result. The

various recipes given are recommended by statements as to the capabilities of blades which have been subjected to the described treatments. Thus it is described how to temper a blade so that it will cut off an elephant's trunk, or so that it will be fit for piercing stones, or so that it cannot be whetted on a stone or blunted by other *iron* instruments. The chief variations in the tempering process seem to have been effected by using a variety of liquids for the quenching—a means which is employed at the present time. There are mentioned as imbruing materials blood, ghee, water, milk from a mare, a camel, an elephant, a mixture of fish-bile, deer-milk, horse-milk and goat-milk blended with toddy, an unguent compounded of the milky juice of the *calotropis* (the use of this to be preceded by rubbing the blade with oil), goat's horn ink, dung from doves and mice, and finally a stale mixture of potash of plantains with buttermilk. From the same source we may infer that the workmen of this period were able to impart a really high finish to the weapons they manufactured, for we find that a king was enjoined not to look at his own face in his sword—an act he would scarcely have attempted in any but a very highly polished blade.

From *Manu's Code*, which is supposed to have been written about 900 B.C., we learn the manner in which the people were divided into castes at this early period. We find that the present division was not then in force, but that there were four chief castes and minor mixed classes resulting from the inter-marriage of members of the four original castes. Many artisan trades were specially assigned to these minor mixed classes, but there is no definite mention of the blacksmith's trade being assigned to any particular class. At the same time there are various passages in the book which show clearly that the use of iron was very common, not only for the manufacture of weapons, but for other purposes such as for tipping the share of the plough, for bedsteads, and for personal ornaments.

B.C. 150 to A.D. 400.

From B.C. 150 onwards we are able to separate to some extent the history of Bengal from that of the rest of India—at least so far as our subject is concerned. We are able to get very valuable information for the period B.C. 150 to A.D. 400 from a study of temples built in Bengal during this period and which still remain in good preservation. The most important of these are the rock-cut temples of Udayagiri Hill, Orissa (circa B.C. 150), Buddha Gaya (B.C. 100–100 A.D.) and the Amravati tope in Orissa (A.D. 300–400). On and about these temples are many well preserved sculptures of warriors wielding swords, daggers, spears, bows and arrows, battle-axes, shields, etc., and from these we are able to get very valuable information as to the shape and design of these weapons. That the weapons depicted are those which were used in Bengal at this period we may safely conclude from the fact that the temples are built in Bengal, and that the weapons were chiefly if not entirely made of iron or steel, and thus of direct interest to us, we may conclude from the frequent mention of iron and steel weapons in the *Vedas* (*vide supra*) at a much earlier period.

In Plate I are a number of drawings of weapons taken from the hands of warriors in the sculptures at Udayagiri, Barhut, Buddha Gaya and Amravati. The drawings are all made to a uniform scale of one inch to one foot (on the assumption that the length of a man's forearm is 18

inches). Almost all the sculptures which are of interest to us have been very carefully photographed or lithographed to illustrate Fergusson and Burgess, "Cave Temples of India," Fergusson's "Tree and Serpent worship," Cunningham's "Stupa of Barhut," and Rajendralal Mitra's "Antiquities of Orissa" and "Buddha Gaya"; also there are casts of some of the more important in the Archæological Gallery of the Indian Museum in Calcutta.

We may note the two widely different types of shield depicted at Udayagiri and at Amravati respectively [Plate I, Figs. 11 and 9 (*a*)]—the one exceedingly massive and apparently circular, the other very long and narrow and of slight construction. The swords are of many shapes and sizes. That depicted in Fig. 3 is a barbarous looking weapon, and reminds one somewhat of the sacrificial knives at present used in Bengal for cutting off the heads of goats. Figs. 1, 2, 3 and 4 are all characterised by their massiveness. Figs. 1 and 4 recall somewhat the shape of the short Roman sword, but they are very much longer than the Roman weapon. A sword somewhat similar to Fig. 1 was used by the Assyrians, and the Greeks of the historic age used a sword somewhat similar to that depicted in Fig. 2 (*a*). Spears do not occur at Udayagiri or Buddha Gaya. Fig. 1 (*a*) is similar to an Assyrian spear. A careful comparison of these weapons with those used by other nations at or before this period would no doubt be a very interesting historical study.

The weapons are certainly the most interesting objects portrayed at Udayagiri, Buddha Gaya and Amravati so far as we are concerned, as they were almost certainly all made of iron or steel. There are, however, other objects which were probably in part made of iron, *e.g.*, the implement used by the mahout in prodding his elephant [Fig. 5 (*a*)], which is of almost identical pattern with the implements at present used for this purpose. The wheels of chariots were probably bound with an iron tyre. On one of the friezes at Amravati [*see* Plate xcviii, "Tree and Serpent Worship" by J. Fergusson] agriculturalists are depicted at work using *kodalis* very similar to those now employed.

We are almost entirely dependent for our knowledge of this period B.C. 150 to A.D. 400 on the temples already mentioned. I have, however, found one weapon in actual existence which is supposed to have been made before the Christian era. This is a spear or lance known as *Peshro bullum*, which belongs to the Nawab of Murshidabad and is always carried at the head of processions as a trophy. It is said to have originally belonged to Vikramaditya and to have been taken by the Muhammadans from the Hindus. It is made of beautifully tempered steel inlaid with gold, and bears on the blade the image of Vishnu on the one side and of Goroor on the other. The character of the ornamentation on the blade bears very marked resemblance to much of the carving and ornamental work on the Orissan temples, and it appears probable to me that this spear was made in Bengal. If so, it is at the same time the oldest and the finest piece of work in steel which Bengal can boast. This spear is depicted in Plate III, Fig. 2 (*a*).

A.D. 400 to A.D. 1400

The Orissan temples of Bhuvanesvar (650 A.D.) and Kanarak (1237 A.D.) are very rich in well preserved and richly detailed carvings, and from these we can continue our study of the weapons of Bengal. Plate II and Plate III,

Fig. 1, are taken from Rajendralal Mitra's "Antiquities of Orissa" in which the Orissan temples of this period are described in detail. Again, the careful comparison of these weapons with those of other nations would form a very interesting study. There is depicted here a short broad sword or dagger [Plate II, Fig. 1] which is exceedingly like the Roman sword, even to the severely rectilinear outline of the guard. There is another weapon which has been frequently described [Plate II, Fig. 22]. It is in the hand of a kneeling figure, armed also with a very small circular shield and preparing to receive a blow from his antagonist, who is mounted on an elephant. This weapon has been described as like a *kukri*, and it has been suggested that this figure represents one of the aboriginal inhabitants of Orissa. It appears to me, however, that this weapon is quite unlike the Sikkim or Nepalese *kukri*, but is similar to a kind of dagger which is said to come from Bhutan. A shield [Plate III, Fig. 1] from the temple at Kanarak is specially worthy of note for the elaborate ornamentation it carries. "It is nearly 2½ feet in diameter, bound round the edge with a metal rim and decorated with an outer band formed of circular plates of metal bearing impressions in relief of men, horses, elephants, deer, fishes, birds, tortoises, lizards and floral scrolls, and having a scolloped inner edge. A medallion of a chaste design covers the centre and to it is attached a thick bushy yak tail *chauri*; a second *chauri* of the same kind but with a differently formed handle hangs from the top. For distinctive badges it has two well-formed lizards."

But Kanarak yields us also something more valuable than sculptures. Here large beams of iron have been used in the building of the Black Pagoda and still remain. The date of this building is fixed by Fergusson in the latter half of the 9th century, but Stirling gives it a later date, viz., 1241. In front of the entrance to the temple, which is on the east side, amongst the stones, lies a bar of iron 23 feet long and 11½ inches thick and broad. Iron beams are also employed to support the roof in the Jagamohan or porch, now the only part of the temple standing. Mr. Fergusson describes the interior of this building (History of Architecture, page 428), as follows:—"Internally the chamber is singularly plain, but presents some constructive peculiarities worthy of attention. On the floor it is about 40 feet square and the walls rise plain to about the same height. Here it begins to bracket inwards, till it contracts to about 20 feet, where it was ceiled with a flat stone roof, supported by *wrought iron beams* . . . . showing a knowledge of the properties and strength of the material that is remarkable in a people who are now so utterly incapable of forging such masses. The employment of these beams here is a mystery. They were not needed for strength, as the building is still firm after they have fallen, and so expensive a false ceiling was not wanted architecturally to roof so plain a chamber. It seems to be only another instance of that profusion of labour which the Hindus loved to lavish on the temples of their gods."

With the possible exception of the *Peshro bullum* already described, the iron beams in this temple are the oldest pieces of iron in the province and are worthy of careful examination. I do not know on what grounds the beams are described as of *wrought* iron by Fergusson, and I am not aware that any samples of the iron have been taken for chemical analysis

or mechanical tests. It may be noted that the celebrated iron pillar at Delhi is supposed to be of about the same age as these beams or even earlier (A.D. 400, according to Fergusson), and that this has been shown to consist of pure wrought iron by chemical analysis.

Supposed to belong to this period also is a large iron gun [Plate IV, Fig. 1] known as the *Bachawali tope*, now standing on two masonry pedestals on the maidan between the palace and the Imambarah of the Nawab Bahadur of Murshidabad. P. C. Mazumdar in the "Musnud of Murshidabad," 1905, says:—"The gun was made between the 12th and the 14th centuries, probably by the Muhammadan rulers of Gour." In the same place the construction of the gun is described as follows:—" . . . . consisting of two pieces of different diameters. The smaller portion, which is the chamber, is 3 feet and 7 inches long with a girth of 4 feet and 4 inches; and the larger portion, namely the barrel, is 11 feet and 6 inches long with a girth, at the muzzle, of 7 feet and 9 inches. The diameter of the bore at the muzzle is 1 foot and 7 inches. The touch hole has been plugged with melted iron. Eleven rings bind the wrought iron barrel, the inner surface of which bears ample evidence of the gun's great antiquity. The rim round the muzzle is ornamented with petals, while one of the rings resembles a string of beads. On the upper half of the barrel surface, near the muzzle, fourteen lines, seven on each side, are inlaid with brass. Eight smaller rings are attached at various points. The breech plug is driven until its chamfered end dovetails and fits tightly into the chamber of the barrel, which are tied together with the rings attached to each."

This gun certainly is a most curious article. It is, so far as I am aware, the only breech-loading gun ever attempted until quite modern times. The English were only using muzzle-loaders in 1760. It is difficult to conceive how the gun can ever have been fired without the breech-barrel blowing out. The workmanship of the gun is very rough. As to the method of its construction, I do not think anything can be said with certainty in the absence of tests of the metal of which it is made. On the chamber I noticed the same transverse markings which I shall have to notice later in the great gun called *Jahan Kosha* which also lies at Murshidabad. These markings may perhaps indicate that the tube was built by bending a strip of wrought iron spirally round a mandril, as in the construction of small arms at Monghyr. Within the barrel there are some very curious markings. There are two lines which run longitudinally down the barrel, one on each side. These make it appear at first as though the barrel had been cast and these were the lines at which the two halves of the mould met. In places corrosion has occurred along these lines showing quite a thin innermost layer and beneath this rib-like transverse pieces about 3 inches wide at intervals of about one foot along the barrel.

Rajendralal Mitra (Antiquities of Orissa) has pointed out an indication of the universal use of iron in Bengal in this period. Most of the Orissan sculptures, depicting women, are ornamented with bracelets precisely similar to the *khâru* of the present day. The most essential point now is that the *khâru must* be made of iron, and probably this has been the case so long as the *khâru* in its present form has been worn.

A reference to another use of iron in a book of this period may be noted. In the *Káliká Purána* it is stated that a plate for food made of magnetic iron is most beneficial in overcoming anasarca, jaundice and anæmia.

A.D. 1400 onwards.

After the conquest of Bengal by the Muhammadans it is certain that all the methods of working in iron and steel and of the armourers' trade known to the Muhammadans were introduced into Bengal. There is no doubt that the native smiths learnt much from the experts who came with the Muhammadans, and that the work produced in Bengal suddenly improved in technique; but at the same time we may deplore the Muhammadan conquest as having almost entirely effaced any characteristic indigenous designs or workmanship, so much so that it is now very difficult to find any designs of arms or methods of ornamentation thereof which can be said to be peculiar to Bengal. Weapons were made in Bengal, in Patna, Monghyr, Dacca, Murshidabad and Burdwan, which in design and ornamentation cannot be distinguished from the arms of Persia, Arabia and the Punjab. It is well known that the Muhammadan Emperors took the keenest interest in the manufacture of arms of all kinds. Akhbar is himself described as skilful in the making of guns and the casting of ordnance, and the most proficient artisans of Europe were induced to come to the Emperor's court to superintend the construction of arms. About the time of Akhbar great attention was given to the manufacture of guns (small arms), but the cannon appear to have been chiefly cast from brass.

It is difficult to find specimens of arms which one can be sure were made in Bengal in the 15th and 16th centuries. There is a large cannon now lying at Murshidabad, known as the *Jahan Kosha*, made of iron, which bears an inscription to the effect that it was manufactured at Jehangir Nagar *alias* Dacca under the supervision of Shere Mahomed and the clerkship of Haraballav Das by Jonardan Karmokar in the month of Jamadinssani of the year 11 of the Joloos, *i.e.*, 1637 A.D. [*see* Plate IV, Fig. 2]. Another inscription also states that the cannon is made of a composition of eight metals, namely, gold, silver, copper, lead, zinc, mercury, iron and tin, but at any rate it appears to be chiefly iron. The metal is very little corroded, which is remarkable considering its age. Here again the chemical analysis and mechanical tests of a sample of the metal would most satisfactorily solve the problem of the construction of the cannon, but from circumstantial evidence it would appear to be wrought. The barrel shows signs of transverse or rib-like markings, which suggest that it was built by twisting an iron band into the form of a spiral round a central core, so that the successive coils of the spiral were in actual contact and then heating and welding together the coils. From an examination of the muzzle-end of the cannon one might suggest that the barrel is built of two or three tubes, as in modern big guns. The ornamentation on the outer surface of the barrel is evidently wrought work, and the design appears to me to be Florentine or Mediterranean in character. "The cannon is 17 feet and 6 inches long with a girth of 5 feet at the touch-hole end. The diameter of the touch hole is $1\frac{1}{2}$ inches. That of the orifice is 6 inches. The weight of the gun is 212

maunds and the powder required for the charge is 28 seers" (*The Masnud of Murshidabad*).

The weapons of the 18th century are better known, as many specimens are preserved. In the palace of the Maharaja of Burdwan there are weapons of this period of which the exact history is known. In the village of Kamarpara, eight miles from Burdwan, there lived many smiths who made all the arms for the Raj. There is a sword in the possession of the Maharaja, of which the following story is told:—A smith from Kamarpara brought this sword for sale to the Raja (the warrior Raja, the father of Raja Chitra Sen Roy, who reigned about 1700), but asked such a high price that he was ridiculed and dismissed. On going out from the palace he chopped through in one stroke of this sword the trunk of a large tree which stood near the gateway of the palace, but cut it in such a way that the tree remained standing. In a few days the tree began to wither and die. On the Raja making enquiries he discovered the reason of the tree's withering and purchased the sword from the smith at the original price asked.

There are old matchlock guns in the palace which were made at Kamarpara and used in a battle in 1761 by the army of Maharaja Tiloke Chand Bahadur against the English under Captain Martin White [Plate V, Fig. 3]. There are also spears which were ordinarily used by the armies of the Raj at this time. Two of the most characteristic forms are known as *bichhu* or *barchha*, a spear with two corkscrew-shaped prongs [Plate V, Fig. 10] and *bigli*, a spear with a flambent blade reminding one of the conventional representation of lighting.

In the armoury of the Nawab Bahadur of Murshidabad are many weapons of this period made in Bengal. Arms for the Nawab of Bengal were at one time largely made at Patna. Monghyr was famous for its guns. In the earlier part of the 18th century these guns were match-lock of the same pattern as those made at Kamarpara. Towards the end of the century guns were also made at Monghyr according to the pattern of those used by the English. The mistries of Bhagalpur produced a sword recognisable by the characteristic end of the blade [Plate V, Fig. 4]. The mistries of Burdwan made swords also for the Nawab of Bengal. In the armoury at Murshidabad there is an executioner's sword (*Tega Burdwani*) made at Burdwan of characteristic shape [Plate V, Fig. 5]. It appears that smiths came from Burdwan to settle round the court of Murshidabad, and there are in the armoury many forms of spears which were no doubt employed in the armies of the Nawab of Bengal and manufactured at Murshidabad [Plate V, Figs. 2, 6, 7, 8, 9, 11, 12 and 13].

The chief characteristics of the weapons which we can assign to Bengal at this period are simplicity of design and absence of ornamentation. But as already mentioned there were undoubtedly manufactured in this province many weapons after the pattern of Arabian, Persian and Punjab arms which could not be distinguished from the patterns. There is only one spear in the armoury at Murshidabad which shows ornamentation of some originality, and may have been made in Bengal at this period. This carries a design in low relief of an elephant, a tiger, and an antelope [Plate III, Fig. 2 (*b*)].

A peculiar kind of spear named *pata* and used in Muhammadan religious processions is probably characteristic of Bengal [Plate V, Fig. 1].

There were undoubtedly many other places than those mentioned at which arms were manufactured in the 18th century and before. There is a very old cannon 12½ feet in length lying in the jungle which now grows on the site of the old fort of Bishunpur in the Bankura district. This was probably manufactured here when the Bishunpur Raj was at its height between the 11th and 18th centuries. At Suri there are a number of small cannon of unknown age used as ornaments round the Civil Courts. These came from Rajnugger, which was the seat of a Raj of considerable importance. The district report from Gaya says:—"There used to be a considerable industry in these parts in the manufacture of steel weapons and implements, but it has decayed since the death of the late Maharaja Sir Jai Pergash Sing Bahadur, K.C.S.I." The Collector of Khulna writes:—"Protapnagar (in the district of Khulna) has a history of its own. It is said that all the guns and implements of war required by Raja Protapaditya, who flourished in the first-half of the 17th century, used to be manufactured in this village."

CHAPTER II.

A STATISTICAL ACCOUNT OF THE PRESENT INDUSTRY.

I.—Number of Persons occupied in Iron and Steel Work, their Distribution by Districts, their Caste and Religion.

The Census Tables afford us the only statistical information on this subject. The tables which are here given are abstracts or compilations from the volumes dealing with Bengal of the Census of India for 1901. It is perhaps scarcely necessary to repeat here that the Occupation Tables are the least satisfactory part of a census and that they do not admit of profitable examination in detail. Since the division of Bengal is subsequent to the census of 1901, it is almost impossible to prepare statistical tables for the restricted Bengal separate from East Bengal. Something has been attempted in Table II by putting the divisions of Rajshahi, Dacca and Chittagong in italics, and by omitting these divisions from the total an estimate is formed of the total number of workers in restricted Bengal. The difficulty recurs, however, in the statistical examination of the iron and steel trade: the statistics of the trade for 1901 necessarily refer to undivided Bengal. *The year 1901 is the latest for which we can get a fairly complete statistical survey both for occupation and trade, and for the sake of coordination and comparison this year has been selected.* It must be understood, therefore, that the statistics given in this chapter refer to undivided Bengal, except when the contrary is explicitly stated.

In Table I, abstracted from Table XV, Occupation, Part A of the Census of Bengal, 1901, are given the number of workers in iron and steel in the whole province, the classification by occupation being given in considerable detail, viz., in the *groups* of the Census Tables.

Table I.

Group No.	Occupation.	Total number of actual workers in British territory in Bengal.	
	24.—Railway and Tramway plant.	Males.	Females.
167	Railway and Tramway Factories: owners, managers and superior staff.	64	...
168	Railway and Tramway Factories: operatives and other subordinates.	1,363	44
	36.—Tools and Machinery.		
225	Machinery and engineering workshops: owners, managers and superior staff.	105	...
226	Machinery and engineering workshops: operatives and other subordinates.	6,589	35
227	Knife and tool-makers	720	14
228	Knife and tool-sellers	283	15
229	Knife and tool-grinders	58	...
230	Plough and agricultural implement makers ...	6,481	628
231			
232	Mechanics, other than railway mechanics ...	4,285	...
233	Machinery dealers, etc.	5	2
234	Sugar press makers, owners and agents	81	...

Group No.	OCCUPATION.	Total number of actual workers in British territory in Bengal.	
		Males.	Females.
	37.—ARMS AND AMMUNITION.		
235	Arms and Ammunition Factories: superior staff ...	30	...
236	Ditto ditto: operatives and other subordinates.	455	...
237			
238			
239			
240			
241	Gun Carriage Factories: managers and superior staff...	...	...
242	Ditto: workmen and other subordinates.	255	...
243	Gun-makers, menders, and sellers	112	...
244	Ammunition, gunpowder and firework makers ...	1,267	55
245			
246	Makers of swords, spears and other weapons ...	128	...
247	Sellers of swords, spears, and other weapons ...	10	...
	46.—IRON AND STEEL.		
326	Iron Foundries: owners, managers and superior staff	108	1
327	Ditto: operatives and other subordinates ...	1,827	14
328	Workers in iron and hardware	79,651	2,792
328(a)	Iron smelters	673	176
328(b)	Lock-makers and sellers	93	3
329	Sellers of iron and hardware	2,964	504
	58.—RAILWAY.		
414(a)	Railway mechanics	2,224	...
	60.—WATER.		
427	Dockyards: workmen and other subordinates ...	5,700	161
	All branches of iron and steel work	115,531	4,580

The total population of Bengal, exclusive of Native States, was in 1901 returned as 74,744,866, and therefore *the number of workers in iron and steel per 10,000 of the population was 15·4 (male) and 0·5 (female) or 15·9 in all.* From this table we may also get a rough idea of the number of persons employed in iron and steel works conducted on European lines, for we may assume that groups 225, 226, 232, 235, 236, 241, 242, 244, 326, 327, 328 (a), 414 (a), and 427 are all so employed. The total number of persons in these groups is 20·2 per cent. of the total number of workers in iron and steel.

In Table II, compiled from Table XV, Occupation, Part B of the Census of Bengal, 1901, is given the distribution by districts of the workers in iron and steel. In the case of small branches (groups) of the industry in which only a few persons are employed, the distribution by districts is not given, and therefore the total number of persons returned in Table II is somewhat less than in Table I.

TABLE II.—*Distribution by districts.*

DIVISION AND DISTRICT.	226.—Machinery and engineering workshop operatives and other subordinates.	230.—Plough and agricultural implement makers.	232.—Mechanics other than railway mechanics.	327.—Iron foundries: operatives and other subordinates.	328.—Workers in iron and hardware.	328a.—Iron smelters.	329.—Sellers of iron and hardware.	414a.—Railway mechanics, fitters, plate-layers, etc.	427.—Dockyards: workmen and other subordinates.
Burdwan Division—									
Burdwan ...	210	64	4	375	2,480	...	79	82	...
Birbhum ...	...	11	3	...	756	...	39	25	...
Bankura ...	3	...	...	...	2 224	...	82	...	...
Midnapore ...	8	7	8	1	3,790	...	108	23	...
Hooghly ..	148	23	23	...	1,367	...	245	1	...
Howrah ...	4,334	3	1,639	935	1,923	...	170	930	1,801
Presidency Division—									
24-Parganas ...	672	15	564	158	3,878	1	256	76	508
Calcutta ...	1,127	2	1,788	332	2,307	...	592	...	3,830
Nadia ...	5	48	...	...	2,563	...	60	46	...
Murshidabad ...	2	106	5	...	1,117	...	39	1	...
Jessore ...	1	40	6	2	3,414	...	2	43	...
Khulna ..	...	...	...	...	886	...	...	3	2
Rajshahi Division—									
Rajshahi ...	*1*	*10*	...	...	*896*	...	*14*	*1*	...
Dinajpur ...	...	*13*	*1*	...	*511*	...	*43*	*44*	...
Jalpaiguri ...	*1*	...	*1*	...	*289*	...	*66*	*56*	...
Darjeeling ...	...	*3*	*62*	...	*160*	...	*2*	*11*	...
Rangpur ...	...	*17*	...	...	*1,001*	...	*13*	*216*	...
Bogra ...	...	*7*	...	...	*302*	...	*1*	...	*8*
Pabna ...	...	*28*	...	...	*886*	...	*4*	*35*	*22*
Dacca Division—									
Dacca ...	...	*14*	*18*	...	*1,398*	...	*100*	*60*	...
Mymensingh ...	*8*	*35*	...	...	*1,408*	...	*314*	*4*	...
Faridpur ...	*3*	*9*	*79*	...	*1,070*	...	*14*	*31*	...
Backergunge ...	*1*	*1*	...	...	*946*	...	*19*	...	*2*
Chittagong Division—									
Tippera ...	...	*10*	...	...	*1,110*	...	*150*	*8*	...
Noakhali ...	...	*1*	...	*3*	*470*	...	*10*	...	...
Chittagong ...	...	*3*	*5*	...	*821*	...	*1*	*73*	...
Chittagong Hill Tracts.	...	...	*2*	...	*133*	...	*2*	...	...
Patna Division—									
Patna ...	39	...	...	...	2,025	...	13	...	...
Gaya	...	...	...	2	3,766	...	...	...	...
Shahabad ...	1	150	...	1	6,670	...	2	...	...
Saran ...	...	14	...	...	2,261	...	4	6	...
Champaran ...	...	72	52	...	1,412	2	7	23	...
Muzaffarpur ...	1	...	...	25	1,837	...	46	9	25
Darbhanga ...	...	116	5	...	1,717	29	1	53	...
Bhagalpur Division—									
Monghyr ...	...	46	121	...	704	640	187	214	...
Bhagalpur ...	...	...	36	...	736	...	47	12	1
Purnea ...	...	...	3	...	1,849	...	33	6	...
Malda ...	...	208	...	...	534	...	74	...	...
Sonthal Parganas ...	1	112	...	3	3,295	...	19	34	1
Orissa Division—									
Cuttack ...	43	926	8	...	2,674	3	22	11	...
Balasore ...	1	22	2	1	543	...	16	61	...
Angul and Khondmals.	...	...	...	...	529	...	...	...	...
Puri ...	...	564	...	...	1,358	...	19	26	...
Chota Nagpur Division									
Hazaribagh ...	...	249	...	...	1,887	...	11	...	...
Ranchi ...	...	3,650	...	...	3,407	...	251	...	...
Palamau ...	...	395	...	...	1,992	...	...	...	...
Manbhum ...	14	1	...	...	4,363	...	9	14	...
Singhbhum ...	...	14	...	3	1,056	...	283	8	...

An examination of this table brings out little information which could not be obtained less laboriously in other ways. It shows very clearly the concentration of machinery and engineering workshop operatives and mechanics in Howrah and Calcutta. The iron foundries are also very clearly located in the neighbourhood of Calcutta and Howrah and in the Burdwan district (the Barakar Iron and Steel Works). It will be noticed, however, that no iron foundry operatives are returned in the Monghyr district, but that this district appears to be absolutely singular in possessing 640 iron smelters, whilst only 3 other districts are shown to possess this class of workman, viz., Darbhanga 29, Cuttack 3 and Champaran 2. There can be no doubt that these curious figures merely represent a statistical error and that these 640 iron-smelters are operatives at the East Indian Railway rolling stock works at Jamalpur of much the same class as the workers at Barakar returned as iron foundry operatives in the Burdwan district. No information can be obtained from the table as to the location of that class of iron workers now rapidly becoming extinct—the smelters of iron by the indigenous method. The table shows a concentration of railway mechanics in the Howrah district which is due to the East Indian Railway wagon shops at Lilooah, and in the Monghyr district to the rolling stock works of the same railway at Jamalpur. I cannot understand a considerable concentration at Rangpur. The workers in iron and hardware, group 328, are the village smiths or Kamars. This group forms 70–80 per cent. of the total workers in iron and steel in the province. They are fairly evenly distributed throughout the province, the average number in a district being about 2,000, the minimum 133 in the Chittagong Hill Tracts and the maximum 6,670 in the Shahabad district. The population of the Chittagong Hill Tracts is less than that of any other district and explains the minimum. The returns for plough and agricultural implement makers are interesting as showing very clearly the essentially agricultural districts. The Ranchi and Cuttack districts show the largest returns for this group.

From this table, by omitting the divisions of Rajshahi, Dacca and Chittagong, we obtain 100,487 workers in iron and steel. From the ordinary population tables we find that the population of these divisions amounted to 24,026,878, and therefore the remaining population of Bengal was 50,717,988. In this way we find *the number of workers in iron and steel per 10,000 of the population was 19·8 over an area roughly corresponding with the present restricted Province of Bengal.*

Very little information can be obtained from the Census Tables as to the *caste* of the workers in iron and steel in the province, as in the tables dealing with occupation by caste the workers in these metals are classed in part with workers in other metals and precious stones and in part with the caterers for supplementary requirements.

The total number of workers in iron and hardware (group 328 of the Occupation Tables) is 82,443. Of these 49,011 or 59·4 per cent. are *Kamars* and *Lohars* and are following their traditional occupation.

The remaining 40·6 per cent. of the workers in this group are of other castes. A few of these are aboriginals, such as the Nepalese *Kamis*, the *Kols* of the Sonthal Parganas and the *Agariahs* of Chota Nagpur for whom also the traditional occupation is in iron and hardware, but the majority are of castes with other traditional occupations which they have abandoned for this work. On the other hand the total number of working *Kamars* and *Lohars* in the province is 208,461, so that of these only 23·5 per cent. have adhered to their traditional occupation.

Concerning the caste of the other workers in iron and steel, the engineering works operatives, the mechanics, iron smelters, manufacturers of arms and ammunition, etc., it is impossible to get any information from the tables.

A sufficient idea of the *religion* of the workers in iron and steel may be obtained from Subsidiary Table VI of the Census of Bengal, 1901.

The following Table III is an abstract therefrom:—

TABLE III.

Occupation.	Distribution by Religion of 1,000 persons following each occupation.				
	Hindu.	Musalman.	Christian.	Animistic.	Others.
Railway and tramway plant ...	592	293	93	22	...
Tools and machinery ...	791	137	20	51	1
Arms and ammunition ...	493	483	24	...	...
Iron and steel	944	23	1	32	...

The most striking features of this table are the small figures for Musalman workers in iron and steel on a small scale (the sub-order iron and steel in this table is chiefly the workers on a small scale—the village blacksmiths) and the large figures for Musalman workers in the manufacture of arms and ammunitions. As this manufacture is practically only carried on in the Government ordnance factories, it means that about 50 per cent. of the operatives in these factories are Musalmans. Generally speaking, we may say that the Musalman workers in iron and steel are almost confined to factories conducted on European lines and that the Musalman blacksmith working in his own home on a small scale is very rarely found. This agrees with my own observations when on tour.

II.—Production and Consumption of Iron and Steel in the Province.

The *production* of iron in the province is very small. The Bengal Iron and Steel Company, Limited, of Barakar have for the last few years

produced about 50,000 tons of pig-iron per annum. The actual figures kindly supplied by Mr. McFarlane, Manager of the Barakar Iron Works, are as follows :—

TABLE IV.

		Pig iron.		Castings.		
		Tons.	cwt.	Tons.	cwt.	qr.
Outturn for year ...	1898 ...	19,719	10	7,833	1	2
	1902 ...	33,180	10	11,499	19	3
	1903 ...	28,318	0	9,644	16	1
	1904 ...	37,882	10	13,958	12	1
	1905 ...	47,411	0	17,741	4	0
	1906 ...	46,877	10	14,487	8	0

Besides this Barakar pig, the only iron produced in the province is an insignificant quantity produced in the small native furnaces of baked clay in Orissa, Chota Nagpur and the Sonthal Parganas.

The production of iron per head of the population is about 1·5 lbs.

The *consumption* of iron and steel cannot be obtained very easily. We may form an estimate of the quantity, however, by considering it as made up of the production in the province *plus* the imports of iron and steel of all kinds *minus* the exports of iron and steel of all kinds. The *imports* and *exports* of Bengal may be obtained from "Reports on Trade carried by Rail and River in Bengal" and from the "Annual Statements of the Trade and Navigation of British India."

TABLE V.—*Imports into Bengal, 1900-1.*

[Compiled from Report on Trade carried by Rail and River in Bengal, 1900-1. Does not include stores imported by Government for Bengal].

ARTICLES.	Quantity.	Cost.
	Mds.	Rs.
Iron and Steel—		
Cast	84,045	2,44,970
Unwrought	17,986	39,578
Wrought	9,56,911	64,39,711
Manufactures	2,61,100	22,19,816
Railway plant and rolling stock—		
Locomotive engines ...	58,368	15,80,501
Carriages and trucks ...	2,60,235	36,28,262
Steel rails and fish plates ...	7,09,326	28,35,961
Sleepers and keys of steel and cast iron.	12,437	42,493
Total ...	23,60,408	1,70,31,292

Table VI.—*Imports into Bengal, 1900-1.*

(Stores imported by Government for Bengal.)

[Compiled from Annual Statement of the Trade and Navigation of British India, 1901, Table 24.]

Articles.	Quantity.	Value.
	Cwts.	Rs.
Hardware and cutlery	...	9,05,681
Machinery and mill-work ...	...	5,00,410
Iron (of all sorts)	205,595	16,13,589
Steel (of all sorts)	44,171	4,11,629
Railway plant and rolling stock ...	...	1,30,56,557
Total ...	...	1,64,87,866

The quantities in cwts of certain of the Government stores have not been returned, but the total may be estimated as 21,82,682 maunds, making the *total imports for Bengal (including Government stores) 45,43,090 maunds or 166,412 tons of the value of Rs. 3,35,19,158.*

Table VII.—*Exports from Bengal, 1900-1.*

[Compiled from Report on Trade carried by Rail and River in Bengal, 1900-1.]

Articles.	Quantity.	Cost.
	Mds.	Rs.
Iron and Steel—		
Cast	2,02,529	5,50,210
Unwrought	1,15,418	2,30,836
Wrought	1,20,719	8,21,930
Manufactures	41,658	3,51,312
Railway plant and rolling stock—		
Locomotive engines ...	1,683	62,956
Carriages and trucks ...	8,394	1,12,707
Steel rails and fish plates ...	49,169	1,91,774
Sleepers and keys of steel and cast iron.	61,467	1,93,952
Total ...	6,01,037	25,15,727

The total exports for Bengal 6,01,037 maunds or 21,016 tons of the value of Rs. 25,15,727.

The total CONSUMPTION *of iron and steel is therefore estimated as 195,396 tons in all or 5·8 lbs. per head of the population.*

III.—Comparison of the Iron and Steel Industry of Bengal with that of England and Wales.

It has proved interesting to institute a comparison between Bengal and England and Wales as to (i) number of workers in iron and steel per 10,000 of the population; (ii) production of iron per head of the population; (iii) consumption of iron per head of the population:—

(i) The number of workers in iron and steel in England and Wales in 1901 has been obtained from Parliamentary Papers, Accounts and Papers 49, Population (England and Wales), Census 1901, Summary Tables, Table XXXV, England and Wales, Occupation of males and females aged 10 years and upwards. A summary of this table is given alongside of a corresponding summary from the Bengal Census, and will be useful to show how far it has been possible to compare the different groups in the Occupation Tables of the two Census Reports given for Bengal and for England and Wales respectively.

Table VIII.—*Number of persons occupied in iron and steel industry. A comparison of Bengal with England and Wales in 1901.*

Occupation.	Bengal (British territories).	England and Wales.
Total population ...	74,744,866	32,527,843
Workers in iron foundries ...	1,950	100,556
Iron smelters	849	85,907 (*a*)
Workers in iron and hardware ...	82,539 (*b*)	249,673 (*c*)
Sellers of iron and hardware ..	3,468	28,206
Arms and ammunition ...	3,417 (*d*)	21,566 (*d*)
Workers in machinery and engineering workshops.	6,729	409,663 (*e*)
Plough and agricultural implement-makers.	7,109	
Mechanics	4,285	
Workers in dockyards	5,861	
Railway mechanics and workers in railway and tramway plant factories.	3,695	23,299 (*f*)
Total workers in iron and steel and machinery.	119,902	918,870
Number of workers in iron, steel and machinery per 10,000 of population.	15·9	282·5

(*a*) Blast furnaces, puddling and rolling and steel smelting and founding.
(*b*) Includes lock-makers.
(*c*) Includes blacksmiths, strikers, tools, nails, bolts, rivets, &c., anchor chain, stoves, bedsteads, lock and key-makers and iron-workers (undefined).
(*d*) It was found impossible to properly separate the manufacturers of explosives only from the manufacturers of ammunition, *e.g.*, shells involving work in steel; and for purposes of more exact comparison all workers in arms and ammunition have been included.
(*e*) Includes pattern-makers, millwrights, fitters and turners, metal machinists, boiler-makers, other engine and machine-makers, ship-plate rivettors, other workers in iron shops, motor and cycle manufacturers.
(*f*) Railway coach and wagon-makers.

(ii) The production of iron per head of the population for England and Wales in 1901 has been obtained from Parliamentary Papers, Accounts and Papers 32, year 1903, Abstract of Labour Statistics of United Kingdom for year 1902-03, page 19. The total production of iron (pig-iron) in England and Wales for the year 1901 is given as 6,792,000 tons. This reckoned per head of the population is 467 lbs For the United Kingdom the corresponding figure is 426 (*op. cit.*, British and Foreign Trade, p. 369).

(iii) The consumption of iron (pig-iron) per head of the population for England and Wales in 1901 is not available The corresponding figure for the United Kingdom is 375 lbs. (*op. cit.*, British and Foreign Trade, p. 369). The results of this comparison are here summarized:—

TABLE IX

	Bengal (British territory).	England and Wales.	United Kingdom.
Number of workers in iron and steel and machinery per 10,000 of the population.	15·9	282·5	...(a)
Production of iron (pig-iron) per head of the population in lbs	1·5	467	426
Consumption of iron or steel per head of population in lbs.	5·8	...(b)	375

(a) Corresponding figure for United Kingdom not available.
(b) Ditto for England and Wales not available.

The percentage number of workers of iron and steel and the production and consumption of these metals in a country may be taken as a measure of the prosperity and civilisation of that country, and the foregoing figures show in a most striking manner the backward state of the Province of Bengal when judged by European standards. Even the least advanced of European countries compare very favourably with Bengal in this respect, *e.g.*, the consumption of iron and steel in Russia is about 17 lbs. per head of the population. On the other hand the iron and steel trade of Bengal compares very favourably with that of any other province in India and with India as a whole. It is the only province in which iron is produced except in insignificant quantities, its engineering firms are the most important in India, and its imports of iron and steel form a very considerable part of the total imports of these metals into British India. It takes about one-half of the total imports of Railway plant and rolling stock and about one-seventh of the total imports of iron and steel in other forms.

IV.—PRODUCTIVE CAPACITY OF THE WORKERS IN IRON AND STEEL IN BENGAL.

An inspection of the workers in this industry in Bengal produces in one the strongest conviction of the futility of the native blacksmith

working on a small scale in his own home, and of the insignificance of the quantity of material he handles. The gain to the country which would result by his employment in factories under European control would be immense. For under these conditions his productiveness is enormously increased and approaches to that of a European worker. It is, however, very difficult to get any figures which will illustrate the point. A rough estimate can perhaps be formed of the amount of imported material which is taken by the native blacksmiths, as distinct from the large firms controlled by Europeans, from an examination of a somewhat detailed table of imports, such as Table X.

TABLE X—*Showing imports of iron and steel, etc., into Bengal, 1900-1.*

[Compiled from General Table No. 24 of Annual Statement of Trade and Navigation of British India, 1901-1.]

ARTICLES.	Quantity.	Value.
	Cwt.	Rs.
Total hardware and cutlery, including platedware.	...	77,42,066
Iron—		
Old, for remanufacturing ...	1,419	3,583
Cast (pig) ...	109,912	3,81,818
Wrought—		
Anchors, cables, kentledge ...	6,696	1,04,478
Angle, bolt and rod ...	145,585	9,76,295
Bar	155,565	10,78,362
Beams, pillars, girders and bridge-work.	10,507	1,11,160
Hoop	36,366	3,27,158
Nails, screws, rivets and washers.	64,577	9,51,784
Pipes and tubes ...	53,077	7,42,009
Rice-bowls ...	64,762	6,74,627
Sheets and plates, galvanized	672,897	71,50,006
Sheets and plates, tinned ...	108,987	13,53,338
Sheets and plates, not galvanized or tinned.	115,747	8,48,308
Wire	18,663	2,36,174
Other manufactures ...	56,847	8,88,050
Steel—		
Angle, channel and spring ...	57,551	4,12,053
Bars	261,518	17,98,311
Beams, pillars, girders and bridge-work.	187,240	11,64,024
Cast	9,333	1,29,208
Hoop	62,963	5,08,604
Plates and sheets	236,849	20,97,657
Other sorts	113,410	9,76,737
Machinery and mill-work (excluding railway locomotives).	...	1,01,81,087
Railway plant and rolling stock—		
Carriages, trucks, and parts thereof	..	20,11,988
Locomotive engines, tenders and parts thereof.	...	8,31,149
Materials for construction—		
Rails and fish-plates of steel and iron.	206,950	10,40,527
Sleepers and keys of steel and iron.	21,352	1,08,342

If we assume that all the small sections, bars, rods, hoop, plates and sheets of iron and steel are taken by the smaller blacksmiths, we shall overestimate the amount of raw material handled by them, for we know that we have taken into account all the material they can use and that in reality a very considerable proportion of the material here specified is taken by the large engineering firms. On this assumption, the total amount of raw material taken by this class of workers in 1900-1 is 1,763,704 cwts. of the value of Rs. 1,54,32,928. We may estimate their total number as 90,380, and this gives us the *amount of raw material consumed per head per annum by the workers in iron and steel on a small scale as 19·5 cwts. of a value of Rs. 170.* This is an outside limit, and probably half this quantity would be nearer the truth.

We shall not be far wrong if we reckon that in large engineering works in Bengal, the value of raw material handled in a year by each worker runs from Rs. 600 to Rs. 1,000; and thus we see that the efficiency of a worker in a factory is, at least, six times that of the worker on a small scale in his own house.

V.—Statistics of the Industry since 1901.

Complete statistics cannot be obtained for years subsequent to 1901. Trade returns are available, but it appeared that a detailed discussion of the incomplete statistical data available would not give any adequate return. The chief feature has been the growth of engineering firms and factories. The rough figures with which I have been supplied show a very large increase in the number of hands employed in such works since the last census was taken.

CHAPTER III.

PRODUCTION OF IRON AND STEEL BY INDIGENOUS METHODS.

Iron-smelting in the first half of the 19th century.

It has already been mentioned in the preceding chapter that the production of iron by the indigenous method is now practically extinct in Bengal. When the industry was in its most flourishing condition and what was the total outturn of iron for the province at this period we have no means of ascertaining. Before the 19th century we have no descriptions of the processes employed. Probably the first description on record is to be found in "the History, Antiquities, Topography and Statistics of Eastern India," compiled from the Survey Reports of Dr. Francis Buchanan, 1807—1813. Here a detailed account is given of the processes of iron-smelting as carried out by the Kols of the Bhagalpur district. In the forties and fifties a number of notes and papers were contributed to the Journal of the Asiatic Society of Bengal on the methods employed in various parts of the province. Kittoe in 1839 wrote on smelting in the Talcheer, Ungool and Dhenkennal States of Orissa (J. As. S. B., Vol. viii, p. 144); Babington in 1843 sent to the Asiatic Society a clay model of the smelting furnaces as used at the Kutterbagga mines, 20 miles north-east of Sambalpur (*vide* J. As. S. B., Vol. xii, p. 164); Welby Jackson in 1845 visited the Birbhum district and contributed to the Journal of the Society a short description of the smelting in this district with an opinion as to the quality of the iron produced (J. As. S. B., Vol. xiv, p. 754); and in 1854 Dr. Oldham communicated to the Society a note on the processes employed in the Rajmahal Hills (J. As. S. B., Vol. xxiii, p. 279). About this time the Court of Directors of the East India Company made some enquiries as to the mineral resources of the province. Dr. Oldham was asked to report on the Birbhum district (Selections from the Records of the Bengal Government, viii, 1853). And a report was also obtained of the iron smelting at Sambalpur (Dr. J. Shortt—Selections from the Records of the Bengal Government, Vol. xxiii, p. 184, 1855). From these papers and reports we may gather that in the first half of the 19th century, iron smelting was carried on in Orissa, Sambalpur and the Bhagalpur districts by almost identical methods. The furnace employed was built of clay and was almost cylindrical, standing from three to four feet high with an external diameter of two to two and a half feet at the top and somewhat wider at the bottom, and an internal diameter of only a few inches at the top, increasing to about a foot at the bottom. A fire-clay pipe passing through the wall at the bottom served as a tuyère and the blast was supplied from a couple of bellows of a peculiar pattern which were worked by a man standing with one foot on each of the bellows and performing a treading action. The construction of this form of bellows will be described in detail later. The furnace was fed with a mixture of charcoal and ore and finally the iron was obtained at the bottom of the furnace as a semifused mass, which was extracted and refined by heating several times at an ordinary forge and hammering whilst hot to force out the slag contained in its pores. We learn that about 300 tons of iron per annum were produced in the Bhagalpur district, but no

estimates are given of the production in Orissa and Sambalpur. The iron smelting at Birbhum differed from the above, the chief difference consisting in the much larger size of the furnaces. Each furnace produced a mass of iron weighing 25 maunds, and Dr. Oldham estimated the total production of the district as 2,380 tons of crude iron per annum.

It was no doubt on account of the larger scale on which the smelting was conducted at Birbhum that the attention of Europeans was especially directed to this district. Soon after Dr. Oldham's visit in 1852 a Calcutta firm, Messrs. Mackay & Co., started the smelting of iron in this district and erected for this purpose a furnace and plant on European lines. No doubt this furnace attracted the majority of the men who had formerly smelted iron by their own method; and when some twenty years later this enterprise was abandoned, the smelting of iron in the district appears to have absolutely ceased. Some drawings by Dr. Oldham of the native furnaces used in the Birbhum district have been reproduced in the Memoirs of the Geological Survey of India [Vol. xiii, Part 2, page 87]. The furnaces were about 7 or 8 feet high and 5 feet across. Their cross-section was not circular but D-shaped, the flat side being the front and at this side the blast was introduced through the tuyères. The bellows were of much the same pattern as in the other districts but larger, and several men were required to work them. The furnaces were built in a furnace-house and there was a platform round the furnaces on which was placed the fuel and ore and on this stood the workman who fed the furnaces with these materials. The forges at which the crude iron was refined by re-heating and hammering were necessarily large, as the mass of iron to be handled was large. Drawings of these forges were also made by Dr. Oldham. They have been described as furnaces, but from the drawings it would appear that they are merely forges with the back of the hearth built up in rather curious shapes.

Iron smelting in the second-half of the nineteenth century.

In the seventies the mineral resources of the province were re-examined by the Geological Survey, and at this period we have a fresh crop of descriptions of the native processes of iron smelting [*vide* Mem. G. S. I., Vol. xi, 1874, Geology of Darjeeling District, by F. R. Mallet; Records G. S. I., Vol. viii, part 4, page 120, The Raijarh and Hinjir Coal-field (Sambalpur), by V. Ball, 1875; Mem. G. S. I., Vol. xiii, part 2. page 87, Geology of the Rajmahal Hills by V. Ball, 1877]. A model of the smelting furnaces used in Chota Nagpur was sent to the London International Exhibition of 1874. Shortly after the appearance of the last of the memoirs above mentioned (in 1881), the third volume of "A Manual of the Geology of India," dealing with economic geology, was published. This volume contains a useful summary of the papers hitherto published on the subject of iron smelting in Bengal, and in addition the author (Mr. V. Ball) describes in detail the furnaces and processes used by the Agariahs in the Palamau subdivision of the Lohardaga district in Chota Nagpur. His description is illustrated by a photograph showing the smelting at work.

Since this date no further accounts of native smelting have been published with the exception of a paper in "The Indian Import and Export Trades Journal" for December 1900, which apparently gives a description

applicable either to the furnaces of Bengal or to those of the Central Provinces.

Iron smelting in 1907

The district reports (1907) show that the smelting of iron from its ores is still carried on to a considerable extent in Sambalpur and to some extent in some of the Tributary States neighbouring on the district of Cuttack; the industry is almost extinct in Chota Nagpur and in the Sonthal Parganas, but is mentioned in the reports. In Birbhum there is no longer any smelting whatever, and no mention of smelting is made in any of the reports from the Bhagalpur Division.

I had the opportunity of watching (on the 18th April 1907) the process carried out by the Kols in the jungle at a short distance from Dumka in the Sonthal Parganas. It scarcely differed from any of the processes which have been in vogue for the whole of the last century in Sambalpur, Orissa, Chota Nagpur and the Rajmchal Hills. The furnace was built on a small hill under the shade of a banyan tree. It was made of clay and carefully dried before use. In form it was almost cylindrical, height 34 inches, outside diameter 26 inches at the bottom, 22 inches at the top, inside diameter at the hearth about 1 foot, at the top 5 inches. On one side a semicircular hole, 1 foot across, was made in the bottom of the wall of the furnace. Into this hole the tuyère was placed resting on a brick, the tuyère consisting of an already baked fire-clay tube 7 inches in length, about 1 inch across at the wider end and slightly conical. The tuyère was then surrounded by a mass of moist sandy clay, the hole in the wall being entirely filled up with this material. The bellows were then put in place. Each bellows consisted of a short cylindrical piece of wood 16 inches in diameter and 5 inches high, hollowed out from the top to the form of a pill-box, with a goat-skin tied over the mouth. Into the side of the cylinder was fitted a bamboo tube 3 feet in length and fitted at its further end with a small iron tube as a nozzle. Two such bellows were put in place with the iron nozzles pushed into the tuyère of the furnace and the bodies of the bellows close together so that the bamboo tubes were as near in line as possible with the tuyère. In the ground on each side of the furnace a pliant stake 8 or 9 feet in length had been driven. These were now bent over towards the bellows and to the stake on the left-hand side was fastened a string which was attached to the goat skin of the left-hand bellows so that the stake, trying to spring back into place, pulled up the skin on the bellows. The stake on the right-hand side was similarly attached to the right-hand bellows. The skins each had a perforation. Then a man standing on the bellows, with one foot on each, depressed the right-hand stake and at the same moment closed the perforation in the skin of the right-hand bellows with his foot and by means of his weight drove the air from the bellows into the furnece. He then leant over to the left and repeating the operations on the left-hand bellows sent a blast from the left-hand pipe into the furnace; and thus alternately he threw his weight from the right to the left in a series of operations resembling a man on the tread-mill and gave a fairly steady blast into the furnace. Plate VI, Fig. 1, is a photograph of the furnace here described, and Fig. 2 of the same plate is a diagram to show the various parts more clearly. The skins were from time to time sprinkled with water.

The furnace was filled with charcoal (the charcoal used was of *sal* wood, having been burnt in a hemispherical pit in the ground) and lighted and the blast started. At this time two dabs of vermillion were made on the wall of the furnace just above the hearth, apparently invoking the blessing of the gods on the smelting. Then the charcoal and ore were supplied from the top of the furnace in the proportion of one skip of charcoal to one measure of ore (the measure consisting of a broken earthen water-pot), the blast was steadily maintained and fresh fuel and ore were added as the previous supply gradually worked down into the furnace. The ore employed was a fairly pure hæmatite in small nodules showing a crystalline fracture. These nodules were crushed to a fine powder before use by an old lady belonging to the family of smelters. Carbon monoxide burnt with a blue flame at the mouth of the furnace and that a white heat was attained within the furnace could be seen by peering down the tuyère. After about half an hour a thin stick was pushed into the moist sandy clay wall surrounding the tuyère, and from the hole thus made a small quantity of slag poured out and solidified. Tappings of slag were made about every half hour. The slag was almost black and vitreous and on cooling generally splintered into a thousand pieces. The blast was continued until no more fuel remained, and, in all, probably 1 maund of charcoal and 20 seers of ore were used. This occupied from three to four hours. The blast was continued some time after all the material had disappeared from the top of the furnace; then the tuyère was removed, the sand, etc., brushed away from the hearth, the charcoals raked out from the furnace and quenched, and ultimately the mass of semi-fused iron was dragged out by tongs with long wooden handles, dragged on to the grass and very gently hammered to express some of the slag. Care was taken not to hammer out too much of the slag as the iron is sold by weight. The iron obtained weighed between 6 and 7 seers. The smelters said that this *kutcha* iron sold at 20—25 seers for the rupee, so that the product of their labours was valued at 4 annas. They said that on being refined this would yield half its weight of *pucca* iron.

With regard to the *rationale* of the smelting operation, from the appearance of the slag one would pronounce it to be chiefly ferrous silicate $Fe_2 SiO_4$, and conclude that part of the ferric oxide, being reduced to ferrous oxide, acts as a base and combines with and removes the silica present in the ore as impurity. Thus the process is very wasteful and cannot give a good yield, but at the same time by using only the pure wood charcoal and adding no flux, the iron produced is almost sure to be of high quality, as there is no risk of introducing the objectionable elements, sulphur and phosphorus, along with fuel or flux. It would, however, be quite worth while to confirm this view of the composition of the slag by chemical analysis as it appears that no satisfactory analysis has ever been made of the slag from an indigenous smelting furnace in Bengal. Dr. Oldham (Mem. G. S. I., Vol. I, 1859) discussed the question, but admitted that no satisfactory analysis had been made. He wrote: "Unfortunately there have been no analyses of such products in this country sufficiently detailed to enable a sound opinion to be formed of the real composition of such slags." A rude analysis of slags resulting from similar processes, operating on very similar, though not quite so

siliceous, ores in Birbhum gave to Dr. McNamara 55 per cent. of iron in the slag with nearly 33 per cent. of siliceous matter together with a proportion of lime.

Two specimens of slag were tested, and the results were—

	Iron.	Lime.	Residue, chiefly siliceous matter.
No. 1.—From sandstone ore ...	55·45	6·18	38·37
„ 2.—From hæmatite ore ..	54 00	8·43	37·57

and since that time no analyses of such slags appear to have been recorded.

Character of the metal produced by native smelting processes in Bengal.

As to the quality of the *iron* produced, the mass of iron on being cut with a cold chisel was seen to consist of a very considerable crust of brittle material, apparently almost entirely slag with an exceedingly slender mesh-work of iron, and an inner portion of tough, malleable iron. The brittle outer portion contained so little iron that it could not be worked up at the forge. The inner portion, however, was worked with great ease at the forge and welded perfectly, behaving as charcoal iron of the best quality.

In fact in all cases which have been observed in Bengal the product of the smelting has been *soft iron.* Thus of the iron produced at Birbhum, Dr. Oldham wrote: "The quality of the Birbhum iron, owing to the processes adopted and to its being smelted entirely with charcoal, is essentially different from that of English iron, and though not so valuable for the purposes above alluded to, such as railway works, is more so for other work in which toughness and malleability combined with softness are required." The same geologist also described the iron produced in Orissa as "of excellent quality and highly prized for its tenacity. It is, in fact, like most of the iron produced by the native furnaces in India (when cleaned), *charcoal iron* of the best quality." It is true that the crude iron has sometimes been described as brittle; thus Kittoe said of the iron produced in Orissa: "Some of the iron is of a superior and malleable quality, but much of it is very coarse-grained and brittle." This is explained by the remark of Dr. Oldham: "The iron thus produced by the first process has never been thoroughly fused. It is brittle, owing chiefly to the impurities mixed with it; but these by the continued exposure to the direct action of the blast in the open furnace in which it is cleaned are either melted or burnt out and the repeated hammerings remove the impurities." This writer left the point somewhat vague as to whether the impurities causing the brittleness of the crude iron were melted out or burnt out in the refining. The brittleness is, however, quite sufficiently explained by the large amount of slag mechanically dispersed throughout the mass of the crude iron, and it is unnecessary to suppose that the crude iron contains any impurities (such as carbon) which must be burnt out. If an attempt were made to uphold such an hypothesis, it would be difficult to explain the ease with which practically all the carbon can be

removed during the refining process, and in the sample which I have myself examined I noticed that the inner core of the crude iron which was comparatively free from slag was tough and malleable before it was subjected to any refining process.

In the Geology of India, Vol. III, page 340, Mr. Ball makes a remark which appears to me distinctly misleading. He says: "Lastly, it is distinctly stated that in the large furnaces in Birbhum the iron was produced in a fluid condition and was run into pigs, which were subsequently converted in open hearths into malleable iron." But by carefully consulting all references to the Birbhum native smelting processes, I can find no such statement: in fact Welby Jackson remarked that the iron was taken out in a mass from the bottom of the furnace. It is true that the furnaces set up at Birbhum by Messrs Mackay & Co., of Calcutta, produced iron which was poured into pigs, but these furnaces were a European concern European using methods.

There is, in fact, no recorded observation of the manufacture in Bengal by native methods either of cast iron or of steel. As to whether cast iron was ever produced by native methods in this province, I am not certain; but there appears to be no reason to doubt that *steel* was produced here, though why the art has been so completely lost is difficult to understand. It is not probable that the large quantities of steel required to make swords and spears for the rank and file of the large armies maintained in Bengal from 1500 onwards would all be imported. Mr. Mallet in describing the Geology of the Darjeeling district (Mem. G. S. I., Vol. xi, pt. 1, 1874), mentions the smelting of iron at Sikhbar, a place to the east of the Tista, 5 miles south-east of Kalimpong. He says: "The micaceous hæmatite is not used as it is said to yield a soft iron unsuited to the manufacture of knives. The magnetite is well suited to native furnaces. The *Kamis* assert that it yields a *steely* iron peculiarly well suited for making *kukris* and *bans*." At the present day the *kukris* obtainable in Darjeeling which come from Nepal are said to be made of steel manufactured in Nepal; and a *Kami* in Darjeeling who made *kukris* assured me that for work of the highest class he only used steel which was brought from Nepal. It does not appear improbable that at the time of Mr. Mallet's visit a small quantity of steel was made at Sikhbar by the Nepalese *Kamis* according to methods introduced from Nepal.

In the district report from the Sonthal Parganas, the manufacture of steel in this district in former times is spoken of as a well-known fact: "The manufacture of *steel* also has died out owing to the disuse of weapons among the Sonthals and the introduction of imported steel. The famous Sonthali bullet-proof shields can no longer be manufactured."

On the people engaged in smelting (according to indigenous methods) in Bengal.

In the Rajmahal Hills and the Sonthal Parganas, the iron-smelters belong to the tribe of *Kols*. (The man shown in Plate VI, Fig. 1, is a *Kol*.) In Chota Nagpur also a few *Kols* are occupied in the smelting. The exact relationships and history of the *Kols* it is difficult to give. They are undoubtedly an aboriginal tribe and closely related to the *Sonthalis*. According to some authorities the term *Kol* or *Kolarian* may be applied to quite a number of tribes in Chota Nagpur and the Rajmahal Hills, including the *Mundas*, the *Hos* or *Fighting Kols*, the

Bhumij Kols and perhaps the *Sonthalis.* Their language has affinities to Canarese and Tamil, as also has the *Sonthali* dialect. In facial appearance the *Kols* and *Sonthalis* are very similar. In the Sonthal Parganas at the present day the *Kol* smelters appear to be rather looked down upon by the *Sonthalis,* who will not work in iron. The smelters in this district in fact appear to possess little spirit. They were described by Francis Buchanan in 1807 as very ignorant timid creatures. Whether the *Sonthali* looks down upon all *Kols,* or only considers himself superior to the *Kol* smelters, I cannot say, but according to an old fable the boot would appear to be on the other foot. This fable relates the origin of the different races. Sing Bonga, or God, created a boy and a girl who grew up to be man and woman, and some time after they had lived together and known each other, Sing Bonga came down and asked them what progeny they had; they said unto him, "Grandfather, we have twelve sons and twelve daughters." These twenty-four lifted up their voices and said, "Great grandfather, how can we brothers and sisters all live together?" Sing Bonga said, "Go you and make preparations and make a great feast, rice and buffaloe's flesh, and bullock's flesh, goats, sheep, pigs and fowls of the air, and vegetables;" and they did so, and when the feast was prepared Sing Bonga said, "Take ye two by two, man and woman, that which shall please you most, and that shall ye have for share, to eat all the days of your life, apart from the rest, so that none shall touch his brother's share." And so when the feast was prepared, the first pair and the second pair took buffaloe's and bullock's flesh, even as much as they could carry, and these became the *Kol* and *Bhumij* race; then a pair took the rice; and other pairs, male and female, rice and vegetables, and these became *Brahmins, Rajputs, Chuttries* and other *Hindus*; and others took away the goat's flesh and fish, and became other kinds of *Hindus*; the *Bhooians* took the shell-fish. Lastly, when nothing was left but the pig's flesh, came two pairs and took it away, and these are *Sonthals* and *Koormees* to this day; and when all the feast was cleared away there remained one pair who had nothing, and to them the *Kols* gave up their share and these are the *Ghassees* to this hour.

Another story related by the *Mundas* appears to indicate at the same time the close relationship between the *Mundas* and the *Kol* smelters and the antiquity of the smelting industry among these tribes. It is a curious version of the Fall of the Angels. Once upon a time, heaven was peopled by a race of divinities who were attendant on Sing Bonga. But one day they happened to come across a mirror, and seeing their faces for the first time found they were made in God's image. Inflated with pride at this newly discovered knowledge they refused further service, declaring themselves the equal of God himself. They were promptly expelled from heaven and cast into the lower world known to the *Mundas* as Terasi Pirhi Ekasibasi. In these lower regions they came across large quantities of iron ore and at once made furnaces and started work smelting it . . . . (for the completion of the story *see* "Chota Nagpur" by F. B. Bradley-Birt).

There is no mention of any particular *tribe* being employed in the smelting industry in Sambalpur and Orissa, although it has been stated that the smelters are a distinct class and live in separate villages. They

are undoubtedly of Dravidian origin and probably closely related to the *Kols* of Chota Nagpur and the Sonthal Parganas.

Although, as already stated, a few *Kols* in Chota Nagpur are employed in smelting, the chief workers in this industry in this division are the *Agariahs* and the *Lohariahs*. The *Agariahs* are otherwise called *Agarias*, *Aguriahs*, *Agorias*, *Agiyas* and *Asurs*. These people live mainly in the upper valleys of the Damuda and Karampura, whilst the surrounding uplands are occupied by *Kols* and *Uraons* and the lower valleys of the rivers by *Bengalis*. They are not related to the Dravidian aboriginal tribes and are probably of Aryan (Hindu) stock. They are miserably poor and their condition is altogether most wretched. They are dependent on the *Bengali* money-dealers for advances to enable them to follow their calling and are thus virtually the slaves of these capitalists. The *Agariahs* smelt only the crude iron, and this is passed on to the *Lohariahs* to be refined and made ready for the blacksmith's use. The origin of the name *Agariah* is somewhat obscure. According to one theory, Ag = fire, Agari = firemen. According to a second it is a term of reproach used by the Hindus (A = a negative particle, gura = gods), whilst a third theory makes the name almost a term of admiration given by the non-Hindu tribes in consequence of the skill of the Agariahs at their trade (Asura a name for God).

The *Lohariahs* are also a very low class of Hindus.

The workers at Birbhum were quite different from the smelters in the neighbouring Rajmahal Hills, for Dr. Oldham tells us the two operations of smelting and refining were carried on by two totally different sets of people and, what is curious, by people of different religions, those who reduced the ore in the first instance being invariably *Mussulmans* and the refiners invariably Hindus.

CHAPTER IV.

THE VILLAGE BLACKSMITH AND HIS METHODS.

The workers.

The typical blacksmith in Bengal is a Hindu of the *kamar*, *karmokar* or *lohar* caste, the caste for which blacksmith's work is the traditional occupation. The figures which have already been given in Chapter II show the preponderance of the *kamar* caste over all others in the blacksmith trade. The special caste of *kamar* or *lohar* is not mentioned in Manu's Code. At this time there were only four proper castes,—the *Brahmins*, the *Kshatriyas* or military class, the *Veisyas* or merchants and the servile class of *Sudr s*. The *Sudra*, whose duty was primarily to serve the other classes, might, if other employments failed him, subsist by handicrafts. Besides the four proper classes, a long list of names is given in the Code for the progeny of alliances of one caste with another, or of one of a pure caste with one of a mixed caste, and in many cases artisan employments of definite kinds are allotted to the mixed castes; but it is curious that such an important trade as the blacksmith's is not specifically mentioned. In Bengal at the present time the *Baidyas* or medical caste come immediately below the Brahmins, then the *Káyasthas* or writer caste, and after these come nine divisions called the Nobo Sak, *i.e.*, the *gopa* or cowherd, the *mali* or gardener, the *taili* or oilman, the *tantri* or weaver, the *modaka* or confectioner, the *varaji* or betel cultivator, the *kulala* or potter, the *karmakára* or smith, and the *napita* or barber. From these nine castes a Brahmin can accept water. Below these come numerous castes, such as the *kaivartara* or fisherman, *sauvarnabanij* or goldsmith, etc., from whose hands the Brahmin cannot take water. The transition from the old caste system of Manu's time to the present one has been gradual, and it is impossible to say when the caste of *kamar* was first definitely formed and how it is related to the castes of Manu's time. The probability is that the *kamars* trace their descent from one of the mixed classes, though there is the other possibility that they may be pure *Sudras*. The family names most common among the *kamars* of Bengal proper are Pal, De, Das and Dutt. In Bihar the term *l har* is more frequently used than *kamar*. The district report from Khulna says that the *kamars* (blacksmiths) are divided into four classes, *viz.*, *Jassury*, *Ch glai*, *Saptagain* and *Mamdobelay*.

Nowadays there are Hindus of many other castes who have taken up blacksmith's work, *e.g.*, milkmen and carpenters, and the district report from Burdwan mentions that in the cutlers' shops of that district Brahmans and Kayasths even may be seen at work grinding and polishing knives and scissors.

In Bengal there is not that clear distinction between the castes which may be found in other parts of India, and it would be very difficult, if not impossible, to distinguish a *kamar* or *lohar* from his facial characteristics. The men shown in Plate VII, Fig. 1, Plate VIII, Fig. 1, and Plate IX, Fig. 1, are typical *lohars* and *kamars*.

The district report from Burdwan remarks that the trade of a blacksmith or cutler is certainly unhealthy; that the blacksmith lacks the brawny arms and massive chest of a typical smith, is light of build and pale

of complexion, his face bearing traces of organic weakness. These remarks are equally true of the blacksmith throughout the whole of Bengal.

It is very rare to find a Muhammadan blacksmith in any part of the present Province of Bengal. There are many Muhammadans employed in the large engineering firms of Calcutta; and an industry which it is difficult to class, *viz.*, the small industry which has recently sprung up for the manufacture of steel trunks, appears to owe its birth in Patna to Muhammadans from Allahabad. In the course of a tour over a considerable part of Bengal I made constant enquiries for Muhammadans carrying on the ordinary work of village blacksmith, and only in Murshidabad was I able to find a single Muhammadan blacksmith and his sons. This man had come in his youth from the Punjab or the United Provinces with a regiment which had been stationed at Berhampore.

In the Darjeeling district are to be found Nepalese blacksmiths. They are called *kāmis* and form one of the lower castes of Nepalese.

Methods of working.

The most common type of blacksmith—the man who has not specialised in any branch of his trade—requires next to no tools or outfit. He has his hearth, and bellows to supply a blast to the fire, and he has an anvil, a few pairs of tongs and a few hammers. A cold chisel may complete his most slender equipment. His work is entirely carried on in a small shanty not more than 10 feet by 10 feet. The hearth (*hafar*) is generally on a level with the floor of the shanty. At the back of it there is built a small wall of mud, generally from 6 inches to 1 foot high and from 1 to 1½ feet long. Through this wall or slightly sunk in the ground below it, there passes an iron pipe carrying the blast from the bellows. The bellows (*bhathi*, *bhanti*) are like magnified English kitchen-bellows. The upper board is fixed whilst the lower board is moved up and down by means of a wire, chain or rope which is fixed to one end of a lever. The fulcrum of the lever is provided by a horizontal bar either supported by two upright posts or by one post on the one side and the wall of the shanty on the other. The other end of the lever comes almost over the hearth and to it is attached a chain. The blacksmith squatting by the hearth and handling the piece of iron in the fire with a pair of tongs (*saursi saneso*) with the one hand, with the other pulls the chain and works the bellows. When the piece of iron has been sufficiently heated it is withdrawn by the tongs from the fire and hammered into shape at the anvil (*nihay*, *lehai*, *lehi*). The anvil is frequently of English pattern and obtained from Calcutta (imported). Sometimes an old piece of steel rail serves as a small anvil. The hammers used are of various shapes and known as *martol*, *hathauri* or *hathuli*.

The construction of the hearth varies a little within the limits of the province. Sometimes besides the wall of mud already mentioned at the back of the hearth there may also be built another small wall running parallel to this at the front, or again these walls may be built of loosely piled bricks (as at Burdwan) and be as much as 1½ or 2 feet high. Again, the whole hearth may be raised to a height of 1 or 2 feet and the raised hearth may or may not be bounded by higher walls. Plate VII, Fig. 1, shows a blacksmith's shop of the simplest type. In this case a few loose bricks are piled on either side of the hearth. Undoubtedly the neatest

arrangement which I have seen in Bengal was at Dubrajpur in the Birbhum district (Plate VII, Fig. 2). Here a considerable part of the floor of the smithy was raised to a height of 1 or 1½ feet, the raised platform being made of mud supported at the sides by stakes. The hearth was built on this platform and was surrounded by four mud walls rising as a sort of furnace 2½ or 3 feet high with a base 18 inches square. The front wall had a small hole in it, whilst the side wall was almost cut away by an arched opening through which the work was manipulated in the fire. This rectangular structure was finished at the top by an arrangement which could best be likened to the upper part of a large earthenware *jala*. Alongside of the hearth on the platform was a seat for the smith, several anvils and several hemispherical bowls sunk in the platform containing water for quenching and tempering: and all arranged on the platform within the most convenient reach of the smith. This was in marked contrast to the ordinary smithy which is grimy, littered with all kinds of odds and ends, and apparently with no order or arrangement whatever.

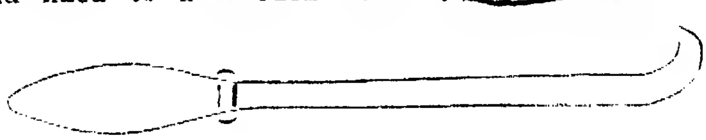
The smith who finds his occupation in making the iron-work for bullock-wagons or *gharis* needs a little more space and has generally a kind of yard adjoining the smithy. He needs to store a considerable quantity of iron bar for the tyres of the wheels and he needs a circular pit for the operation of tyring the wheels. This is effected in the usual way by heating the tyre until it fits easily on to the wheel and then quenching it in position.

The preparation of knives, scissors and razors is rather a special branch of the blacksmith's trade. We may call the blacksmith employed in this work a *cutler*. He requires the usual hearth, bellows, anvils, hammers, tongs and chisels and in addition he requires water for tempering his blades (*pan*, *pahin-halno*), vice (*bice*, *paksawasi*), file (*ret*, *ooga*), drills (*bhumar*), grindstone and polishing wheels (*san*). The water for quenching or tempering the blades may be contained in a trough sunk in the floor of the shop or in any handy vessel, such as an old tin canister. In the Darjeeling district a vessel for holding the water is made of bamboo. Some of the smiths recognise the delicacy of the operation of tempering. Probably the best Darjeeling *kukris* are made of steel which equals or excels in quality any other steel goods produced in Bengal, and the *kāmi* recognises something of the delicacy of his operations. For the best work he uses only *charcoal* as fuel for his hearth and he considers the tempering of his blades an operation requiring care and skill. The grindstones and polishing wheels are characteristic tools of the cutler's shop. They are made of sand and *lakh* or fine grit and *lakh*, and as generally seen are discs about half an inch thick and about 1 foot or 1½ feet in diameter mounted on a wooden axle or spindle 3 to 4 inches in diameter. The spindle is mounted horizontally in a shallow pit and a deeper pit is cut to accommodate the disc. The disc is made to revolve by a cord passing over the spindle. The cord is often worked by hand or may pass over a large driving wheel worked by a treadle (*see* Plate IX, Fig. 1). The district report from Burdwan contains an interesting account of the work in probably the best cutlery shops in Bengal:—

"The blade of a knife, or scissors, is first of all fashioned by the blacksmith. His implements are an anvil, bellows, a hammer, chisel, and a pair of pincers. He

heats the iron or steel in the furnace and beats it to the required shape and size on the anvil. A skilful blacksmith can thus fashion 72 knive blades during the course of the day, two inches to three inches in length, by a quarter of an inch in breadth. The blacksmith hands the rough blades to the grinders and polishers.

"There are two kinds of hones for grinding and polishing and sharpening blades. The first is of ordinary sand found on the banks of rivers and is used for rough work. The second is of very fine grit, obtained by crushing what appears to be a very close grained sandstone, called locally 'kruich pathar.' (As all the specimens were grimy and discoloured, I was unable to identify them satisfactorily.) The sand is mixed with *lakh*, the proportion being one seer of sand to a quarter of a seer of *lakh*. The ingredients are placed over a fire and mixed. The artizan then shapes his wheel on a board with his hands. The solid wheel is about 15 inches in diameter, and its polishing edge is about a quarter of inch in breadth. The polishing wheel of stone grit is made in practically the same way. The 'kruich pathar' is first of all crushed very fine; it is then carefully strained through a cloth, and only the finest grit is mixed wth the *lakh*, in the proportions already indicated. The wheels are then fixed to a wooden pole about 12 inches in girth and about 2 feet in length. This pole passes through the centre of the wheel, and when force is applied, revolves with the pole. A hole is dug in the floor of the workshop, and the pole and wheel are fixed horizontally so as to allow them to revolve easily. The wheel is of course vertical to the pole. The driving power is applied by another wheel 3 or 4 feet in diameter fixed about 10 feet away. A belt of thin rope passes over the indented rim of the driving wheel and round the pole of the polishing wheel. The driving wheel is worked, as a rule, after the manner of a *tread* mill, and enables the operator to revolve the polishing wheel with considerable force and rapidity. The iron driving wheel is of European manufacture. Wooden ones made locally are now very rarely used, the European article being more durable and efficient. The cutler squats on his hams over the revolving polishing wheel. He takes the knife or scissor blade in both hands and applies it to the revolving edge of the polishing and sharpening wheel, dipping the blade in cold water, whenever it becomes too hot to hold. The skilled artisan does the preliminary polishing and grinding on the sand wheel. He then makes over the blade to a confrère who proceeds to apply it to the 'kruich pathar' polishing and sharpening wheel. When the blade is sufficiently sharp and polished, it is handed over to another artizan, who fixes it in a vice, drills the necessary holes, shapes the brass, horn, or ivory for the handle, and fixes the blade thereto. The brass is in thin sheets, and is readily cut with a pair of steel shears made in the workshop. The horn, or ivory, is cut with a saw made locally or imported. It is shaped with a file and fixed to the blade. The horn or ivory is also highly polished by rubbing it in a mixture of brick dust, charcoal and oil. Finally, the knife is again polished on the 'kruich pathar' hone. Inaccuracies of the handle and springs at the back are also ground away, and the article is now bright and beautiful, and ready for sale. In the case of a highly skilled artizan the polish is mirror-like, and equal to that of the imported article; the edge is also equally keen and fine. The operation in the case of a scissor blade is somewhat different. The blade and thumb-ring are polished and rounded on the revolving hones. The blade is then fixed in a vice, and the operator proceeds to polish the ring, and the lower parts, with an instrument called a 'maskolla.' This is a somewha flat blade of steel rounded at the edges and point and fixed to a wooden handle. ~~shaped thus~~ :—



(It is made locally.) This instrument is rubbed forcibly against and all round the ring and lower parts of the scissor. It gives the finished article a very high degree of polish, making it smooth and easy to the fingers. The holes for screws and nails are drilled with an instrument called a 'bhumar.' This is a steel drill made in the workshop; it is 2 or 3 inches in length and is fixed to a round wooden

handle about 8 or 10 inches in length. It is a pointed instrument, and when worked with a bow rapidly bores its way through brass, horn, ivory, iron and steel.

"In the case of the razor blade the process is identical. The blacksmith gives it birth on the anvil; it is then passed over to the polisher and the driller. But very few artizans make razors, and only one or two cutlers lay claim to be able to fashion razor blades of superfine quality. The brittle nature of the steel, and the delicacy of the blades, demand an exquisite judgment and gentleness of touch on the revolving hone. A good razor blade has also to be manipulated with great patience; the skilled artizan working from morning till evening cannot turn out more than two such blades a day: and his profit is not more than 4 annas per rupee. The price of these blades varies according to size and quality from Re. 1-4 upwards.

"It may be observed that horn and ivory are scraped with an instrument called a *randar*. This is a four-cornered piece of steel, 3 inches in height, fixed to a wooden handle. The final polishing is done with brick-dust, charcoal and oil.

"The revolving hones last a month and-a-half in the case of the sand wheel and 3 months in the case of the 'kruich pathar' wheel. In large workshops half-a-dozen such wheels may be seen spinning, so that the blacksmith is frequently under the necessity of making fresh ones.

"Dies for stamping the artizan's name on the heel of the blade are made of steel locally; and I have no doubt that an unscrupulous artizan is able to forge the trade mark and name of a European cutler."

In some parts of Bengal there are a few smiths who can chase ornamental patterns on the blades of knives, *e.g.*, the *Kāmi* of Darjeeling can ornament the blade of his *kukri* and in Dubrajpur ornamental sacrificial knives can be obtained. The pattern is chased on the blade when it is in the annealed state by means of a fine, hardened chisel and a small hammer. A certain amount of brass inlaying on such ornamental knives is also done. The pattern is first chased and the brass is then brazed in.

A specialised class of workers are the *gun-makers* of Monghyr. There are a few other gun-makers scattered about in Bengal, but Monghyr is quite a centre for this work. Here there are 13 gun-makers' shops and 700 to 800 guns are produced annually.

Gun-barrels of three kinds are made, viz., plain, marked with simple twist (*mowa*), and damascened. The simple twist is a more or less regular spiral mark running round the barrel, the marking being in the metal just as in damascened work. The damascened barrel is marked all over with small spirals of about $\frac{1}{4}$ inch diameter. To make a plain barrel a piece of Swedish iron bar is taken and hammered into a strip about 6 feet long, 1 inch wide and $\frac{1}{4}$ to $\frac{1}{2}$ inch thick. This is then hammered into a close spiral such as would be formed by winding the strip round a straight rod. Neighbouring coils of the spiral are touching. Thus a rough tube is made, the bore being considerably less than required in the finished barrel. By heating and hammering the coils of the spiral are welded together and the wall of the tube has now become solid. To prevent the iron being spoilt by so many heatings it is generally covered with mud before being put in the fire. In forging the ends of the tube a mandril is inserted into the bore to prevent the *lumen* closing up. The tube is now bored, and for this purpose an implement is used which may be likened to a large railway carriage key [Plate VIII, Fig. 2 (*d*)]. The barrel is fixed firmly in position passing through a hole in a large post which is itself firmly fixed in the ground. A man now inserts a borer of small bore into the barrel and gradually bores through the barrel. This operation scrapes the sides of

the *lumen* and makes the bore slightly greater and more uniform. A slightly larger borer is now inserted and the operation repeated and gradually the bore is made larger and more uniform until the desired size is attained. This operation must be done gradually and generally takes a man three days (Plate VIII, Fig. 1, shows the operation of boring). The outside of the barrel is now filed up to the desired shape. To make a barrel with the simple-twist marking, a number of strips of Swedish iron, say about ½ to 1 inch wide, ¼ inch thick, and 8 to 10 inches long, are laid alternating with the same number of soft steel strips of the same width and length, the steel used for this purpose being the bands taken from bales of imported cotton goods, etc. About 16 of these strips are piled together and held together by a soft iron strip which is welded round them. We thus have a bundle about 8 or 10 inches long, 3 inches wide and ½ to 1 inch deep showing the edges of the 16 strips at what may be called the surfaces of the bundles. Several such bundles are displayed in the photograph [Plate VIII, Fig. 2 (*b*)]. This will make their structure more easily understood. This is now heated and gradually hammered into a strip about 6 feet long, 1 inch wide, and ¼ to ½ inch thick in such a way that the lines along which the alternate layers of iron and steel have welded run the length of the strip [Plate VIII, Fig. 2 (*a*)]. This strip is now welded with one of soft iron of similar dimensions and the strip thus obtained is used for making a barrel in the same way as described already for the preparation of a plain barrel. Of course the composite layer is kept outermost. To make a damascened barrel a number (say, 8) of composite strips are prepared in the manner already described, but they are made of smaller size. Each strip is then twisted many times until it looks like a long screw, say 3 feet long ½ inch diameter and with a ½ inch pitch. These eight screw-like rods are tied together [Plate VIII, Fig. 2 (*c*)] and forged out into a long strip about 1 inch wide and ¼ inch thick. This is welded to a soft iron strip of similar dimensions and the composite strip is made into a barrel in the way already described. Of course here also the composite layer is kept outermost. After the barrel has been filed up true and polished on the outside, the markings are brought out by the application of a solution of chemicals known as "English mixture."

The guns usually produced are single-barrel muzzle-loading 12-bore shot guns fired by a cap, the cap-nipple being at the side of the breech-piece. The breech-piece is forged and filed out of one piece of soft iron and is quite a complicated piece of work. This is screwed on to the barrel, the screw thread being made by English taps and dies.

The largest shop in Monghyr belongs to one Burri Mistri, who is somewhat more advanced than the rest of the gunmakers. He can make a very good imitation of almost any gun you will give him—double-barrelled breech-loaders with choke-bores, etc. I noticed in his shop a tool for finally polishing the interior of the barrel which was very similar to the tool used at the Government Small Arms Factory at Ishapore for the same purpose, viz., a hard steel tool with a rectangular polishing edge which is packed with pieces of horn, paper, &c., to fit the bore. He can "blue" plain barrels, and temper the lock, triggers, &c., so that they show a play of colours. The locks are generally chased with ornamentation after English patterns, and I saw many samples in

Burri Mistri's shop which were very fine copies of the pattern from which they were taken.

Lastly, we may describe the methods of the worker in iron plate, and take as a typical instance the making of a *ghara* or *gagra*, a vessel used for drawing from the well or for carrying water.

This vessel is represented in Plate IX, Fig. 2 (1). It is seen to be built up of several zone-like strips of sheet-iron rivetted together. The sheet-iron is marked out by a compass [same figure (11)] and cut out by a chisel, and the various zones are hammered until they have assumed their proper curvature by means of a wooden mallet (5 and 6) on an anvil with a concave surface (3). The various zones are put together temporarily and the position of the rivets decided upon and marked. The various pieces are then punched separately and rivetted together in the cold by small rivets made from a thin rod of soft iron. The edges of the various segments are well hammered before they are put together, and after the rivetting the line of junction of two pieces is very vigorously hammered to make a tight joint. For rivetting frequent use is made of the iron clubs (2). These are firmly fixed in the floor of the shop. The *ghara*, even when nearly complete, can be put over one of these clubs, the head of which forms a hard smooth round surface against which the rivet may be driven home. An awkward rivet just in the last stages may be sometimes driven home by the small club (12) or (13) held in the hand inside the *ghara* whilst the outside is pressed against the concave anvil. By way of ornament circles are drawn round the *ghara* by a compass with a chisel-like point (11). The neck is put on last and consists of two sheet-iron collars and a forged iron ring. It would be difficult to explain its structure in words, but this may be readily understood by the sectional drawing (4).

Raw materials used.

Almost without exception, the iron and steel used by the blacksmiths come from Calcutta, being imported from Europe, chiefly from the United Kingdom and Belgium. In Sambalpur, the native iron is still used and perhaps in parts of Orissa, Chota Nagpur and the Sonthal Parganas to a very limited extent. In the Darjeeling district steel from Nepal is said to be used for the best *kukris*. The bulk of imported iron used by the native blacksmiths is in the form of bar, rod, sheets and plates. Mild steel bar is also used to a considerable extent. Of late years, a large proportion of the imported steel of this character has been supplied from Belgium. The mild steel bands used for bales of imported cotton goods, &c., and which are available everywhere as a kind of waste material are largely used. As special qualities of imported material used for special classes of work may be mentioned the Crown Swedish iron used at Monghyr for gun-barrels, and the cast-steel of W. K. Pearce of Sheffield, used for cutlery at Burdwan. The smaller cutlers frequently use old files as steel for their knives and scissors.

It is scarcely possible to make any general remarks as to the price of these raw materials, as the price at any place will depend on the Calcutta rates, on the distance from Calcutta and on the quantities taken by that place. The price of iron and steel in Europe for the last four or five years has remained fairly steady, but within the last few years the war in shipping freights from the United Kingdom and Belgium to Calcutta must have caused

unusual and abnormal changes in the Calcutta rates. Belgium has also of late years been "dumping" steel in large quantities into Calcutta. We may take the rates in 1901 as being more normal than those of the last few years. In this year the average Calcutta rates were roughly Rs. 4-8 per maund for iron bar, Rs. 5-5 for iron sheets and plates not galvanised or tinned, Rs. 5 for steel bar and Rs. 6-2 for steel plates and sheets. At the time of my tour (April 1907) enquiries from the blacksmiths themselves showed that the rates in all the larger cities were much the same, *e.g.*, about Rs. 4-8 per maund for iron bar. In Dumka as might have been expected the price was said to be a little higher, viz., Rs. 5. The rate supplied to me at Darjeeling was probably erroneous as it ran to Rs. 8 per maund. The smelters in the Sonthal Parganas valued their *kutcha* iron at 20—25 seers per rupee, and said that 2 seers of *kutcha* iron would give 1 seer of refined iron, making the value of refined native iron Rs. 3-4 to Rs. 4 per maund in the form of bar. In Darjeeling the prices I was given for *cast-steel* for cutlery appeared excessively high, viz., Rs. 20 to Rs. 30 per maund* for European material and Rs. 40 for Nepal steel.

Conditions of labour, wages, earnings, &c.

By far the larger number of blacksmiths, the makers of rough agricultural implements, work by themselves in their own homes without any assistance. The women-folk never appear to render any assistance except in the Darjeeling district. Nowadays the finished goods are generally sold for cash. The district report from the 24-Parganas states that the cultivators who are the chief customers of the blacksmith pay him either in cash or kind or sometimes in both. Solid mass iron from Sambalpur is on rare occasions accepted by salt merchants from Cuttack who take it in return for salt. But although the blacksmith himself buys his raw material for cash and sells his finished articles for cash, yet he generally only works to order, not having sufficient capital to lay in any considerable stock of iron. The earnings of such a worker may run as low as 2 annas per diem and as a rule do not exceed 4 annas. The dealers in hardware in the larger towns are men with a certain amount of capital and they will place orders with the small blacksmiths round about. In such cases of course the blacksmith loses the middleman's profits, but he may be assured of a steadier demand for his goods.

Workers producing a finer quality of goods, such as cutlers, naturally earn a somewhat larger sum than their less skilful fellow-craftsmen. From eight annas to one rupee or even two rupees (Bankura) per diem may be earned by this class of workers. Frequently too this higher class of work is carried on in larger shops and the workers are the employés of the master cutler. Such daily workers will earn from Rs. 10 to Rs. 20 per mensem or even Rs. 30 may be paid for a skilful polisher.

An interesting system somewhat analogous to co-operation is reported to be in vogue to some extent in the Sonthal Parganas. The blacksmiths often group themselves into a band of six men to conduct a workshop conveniently situated under a grove or a shady tree in the village, while another man supplies the implements and capital. All the six men go on working the whole day, and out of the seven articles manufactured, each of the labourers gets one, while the seventh one is given to the man who supplied the implements and capital.

* This price was also quoted in the Darjeeling District report.

CHAPTER V.

THE VILLAGE BLACKSMITH'S PRODUCTIONS.

In this chapter the more common articles of iron made by the native blacksmith will be briefly described. Many of these are figured in the accompanying plates, and these figures will, it is hoped, make a long verbal description unnecessary. Many of these articles have somewhat different names in different parts of the province. In all cases the most common name has been given, and when any quite different word is also used the locality is mentioned in which this second name is in vogue. For convenience of description the following classification will be adopted:-

(I) Agricultural implements, tools, &c.

(II) Cooking utensils and other articles of domestic use.

(III) Tools and other articles used in various handicrafts and professions.

(IV) Weapons.

(I) Agricultural Implements, Tools, &c.

First in importance among agricultural implements stands the plough. In all parts of Bengal this is made entirely of wood with the exception of an iron tip for the share. Quite generally—in Bengal proper, in Behar, in Orissa,— this iron tip [*phál* or *phár; longal miha* (Orissa)] is a straight piece of iron 1 foot long, 1 inch broad, ½ inch thick, and sharpened at the ends (Plate X, Figs. 1 and 2). It fits into a groove chiselled out for it in the upper surface of the wooden share and projects a little at the tip. It is held in place by one or more iron staples. In Murshidabad and in Burdwan I saw another type of plough-iron (Plate X, Fig. 3) in shape somewhat like the head of a spear, about 14 inches long, pointed at the tip, broadening to about 2½ inches in width and then narrowing rapidly (to form a part corresponding to the spear shaft). This iron is also about ½ inch thick and fitted in a groove on the upper surface of the share, being held in place by a staple driven over the narrow portion.

There is very little iron work about the ordinary bullock-cart. The axle is of iron and there is generally a sort of iron collar (called *pandari* in Orissa) fitting in the hub of the wheel and forming an axle-bearing. This collar is made by welding together two pieces of iron of this shape . The hub is frequently bound with two or three thin iron or steel bands. The wheel is retained on the axle by an axle-pin and there are one or two washers which prevent the axle-pin from cutting into the wood-work of the hub. These various parts are shown in the drawing of the hub of a cart-wheel (Plate X, Fig. 5). The wheel has invariably an iron-tyre (*hal*). It has already been mentioned that the making of tyres for bullock-cart wheels forms a considerable part of the work of village blacksmiths. Except for the axle and wheel the bullock-cart is, as a rule, made entirely of wood. Sometimes the yoke is fastened to the shaft by an iron pin, and sometimes at the ends of the yoke there are iron-hooks to which parts of the harness are attached. Yoke-hooks of the form shown in Fig. 4, Plate X, appear to be characteristic of the Bhagalpur division. They also are apparently termed *hal*.

Horses and bullocks are shod with iron shoes (*nal*). As a rule the shoeing of horses and bullocks is a separate branch of the blacksmith's trade and the farrier is called *nal-band.*

For digging the earth the implement invariably used is the *kodali.* (In Orissa the name *kadal* is given to an implement of this kind, and apparently *fonda, kori* and *kuri* are tools of the same general character.) The *kodali* is the implement which takes the place of the spade. The blade is of the same shape and size as that of a spade, but the handle is affixed so that the implement is used in the same manner as a pick or adze (Plate X, Figs. 6 and 7). It is said that on the introduction of the spade by a European planter the natives could not be made to use it except in the manner of a *kodali*, one man driving in the spade and holding the handle whilst another standing in front lifted the earth by means of a rope attached to the handle low down near the blade. The *kodali* made by the village blacksmith is of soft iron as a rule and the socket for the handle is very massive and clumsy. Nowadays many *kodalis* are manufactured in Europe and imported into this country—I have seen many *kodalis* made by the firm of John Perks & Sons of Wolverhampton. Such imported *kodalis* are made of steel and last longer than the iron implements of indigenous manufacture.

For digging holes, *e.g.*, for fixing a pole in the ground, a crow-bar is used. This may be of iron or steel (*sábal*); or the chisel-shaped end may be of iron but affixed to a wooden shaft. Such an implement is known as *khantá* [*baisakhi* (Behar); *khanadli* (Orissa)]. Pick-axes are also used for such purposes. In Bengal they are generally made with two points (*gánti, gainta, gainti*) as in Plate X, Fig. 8; in Orissa the one-pointed pick, *kunka*, is also known—of the shape shown in Plate X, Fig. 9.

For grass-cutting sickle-shaped implements are used. These may be of soft iron or of steel or partly of iron and partly of steel. Those of soft iron are generally filed so that they have a saw-like or toothed edge and are known as *kachia* or *kásthá*; those with smooth edges, generally containing some steel, are termed *hassua.* (In Orissa the term *dá* or *dád* is given to a sickle-like implement.) A number of drawings of these sickle-like implements are given in the plate, showing to what extent the shape may vary (Plate X, Figs. 10, 11, 12, 13, 14 and 15). In the narrow part of the *kachia*, just in front of the wooden handle, there is generally a kink. Scythes and other large grass-cutting implements are known in Bengal, but are very little used. Frequently grass is torn up by the roots by the men who get grass for horses. For cutting (!) grass in this way an implement known as *khurpá* is employed. This form of *khurpá* is something in shape like a trowel (Plate X, Fig. 19). The grass-cutter takes a tuft of grass in his left hand and slides the *khurpá* along the earth to cut the grass off at the root, but more often than not the result is that the grass is torn up root and all. Another form of *khurpá* with a long narrow blade instead of a short broad one is used as a weeding tool by gardeners (Plate X, Fig. 20). Other forms of weeding tools are the *ironee* and *bida* (Orissa). The *nironee* is in shape very like a tinker's soldering-bolt (Plate X, Fig. 21), whilst the *bida* is apparently like an English garden-fork.

The *garaser* (*gourasi, gárásá*) is used for chopping straw for cattle. The back of an iron blade about 6 inches long is let into one side of a

heavy wooden mallet (Plate X, Fig. 16), and the implement is used for cutting straw into small pieces, for which purpose the straw is laid on a flat surface such as a piece of wood. The following implements are described in the report from Sambalpur as made in this district for threshing *dhan*:—*Kahali*, apparently something like a shepherd's crook, used for tossing about hay when threshing *dhan*; *sâmi*, an iron ring, which is fixed to a pole for husking *dhan*; and *dai*, used for threshing *dhan*.

For cutting down trees and for wood-cutting in general the implement used is the axe or adze (*kuráli*, *kulhari*, *kudhari*; *tanga*, *tangi*, *tangari*; *basla*, *basula*, *basuli*). The ordinary axe (Plate X, Fig. 18) is made of one piece of iron, wedge-shaped, and the hole for the handle is forged through the thicker end of the wedge, its axis parallel to the cutting edge of the axe. Such an axe-head is frequently 8 inches long and almost 3 inches thick at the broad end, so that it is a very clumsy looking tool. The large mass of metal gives it, however, considerable momentum when in motion. Sometimes the axe-head is a less massive affair and instead of the handle fitting into a hole in the head, the position is reversed and the axe-head is shaped with a kind of spike or tongue which fits into an iron-socket on the end of the shaft. By this arrangement the axe may be used with the cutting-edge either parallel or at right angles to the length of the shaft [*see* Figs. 17 (*a*) and 17 (*b*), Plate X]. An implement like a crow-bar, *kuradi*, may be used for splitting timber. For cutting small stakes and billets of wood, for pruning trees, etc., a bill-hook is largely employed. In Bengal this is called *dáo*, in Behar and Orissa *katari*, and in Chota Nagpur *dabia*. A number of drawings in the plate (Figs. 22, 23, 24, 25. 26, 27, 28, 29 and 30) show the variations in the shape of the bill-hook which occur in the province. The bill-hook is undoubtedly one of the most extensively used implements in this province. It is at the same time an agricultural and a household implement and is useful for a great variety of purposes.

Vessels which are used for drawing water from wells will be described under the head of domestic utensils; for irrigating the fields there is frequently used a canoe-shaped vessel (*dhunti*, *dhuni*), swung by ropes from an arrangement of bamboo poles. One end is depressed and is thus brought under the surface in the available water on one side of a *band*. On being released the *dhunti* swings up by its own weight and pours the water thus taken up into the dry field on the other side of the *band*. These vessels are generally made from the dug-out stem of palm-trees, but of recent years sheet-iron has been used to some extent for making them.

(II) Cooking Utensils and other Articles of Domestic Use.

(*a*) *Cooking utensils.*

Portable fire-grates made of iron are not used by Bengalis, as all their cooking is done over a hearth built of mud (*chulha*), but nevertheless a large variety of such portable fire-grates (*ungatis*) as shown in Plate XI, Figs. 1, 2 and 3, are made by native smiths, perhaps only for use in the houses of Europeans. Such *ungatis* may be seen in large quantities in the hardware dealers' shops in any of the large bazars. Besides fire-grates over which a pan or dish may be heated, ovens (*tezal*) are made

like large pill boxes of sheet iron 20 inches or more in diameter and about 8 inches high, standing on short legs (Plate XI, Fig. 4). Sweetmeats may be kept hot in such an oven, by putting coals both underneath and on the lid. For handling hot coals iron-tongs (*chimta*) are used. In Orissa a kind of spoon is also used for this purpose (*nia kadhâ chatu*). For baking bread a circular iron plate slightly convex upwards (*táwá*) is used (Plate XI, Fig. 5). This is simply placed over the stove (*chulha*) with the slightly convex side uppermost and when it is hot the dough covered with flour is placed thereon. Iron frying pans for vegetables, &c., are termed *karahi* (*pithakara chatu*, Orissa); large iron cooking pots *karah*. The large cooking pots for rice, stew, &c., are generally not made of iron but of tinned copper. Covers for cooking pots are sometimes made of iron; they are called *dhákná*. Iron plates (*thalis*) are sometimes used. A large spoon used for cooking rice [*hátá*, *kulchhul* or *cheniche* (Behar)] (Plate XI, Fig. 6) is always made of iron. So also are *khanti* (*pithapatia*, Orissa) an implement made out of one flat piece of iron plate (Plate XI, Fig. 7) and used as a stirrer and for turning cakes when frying; and *jhánjhará* (*júlichatu*, Orissa) a large sieve-like spoon used for lifting sweatmeats from the oil in which they have been cooked. A *jhánjhará* consists of a handle about 1 foot long and a flat disc about 6 inches in diameter perforated with a large number of holes through which the excess of oil can flow away as the sweetmeat is lifted from the frying-pan (Plate XI, Fig. 8); *mathachatu* (Orissa) is a similar utensil without the holes in the disc. Almost every household in Bengal possesses a *banthi* (*panakhi*, Orissa) which is a kind of knife fixed almost upright in a horizontal board (Plate XI, Fig. 11) and used for cutting vegetables and fish. The vegetable to be cut is pressed against the knife. The *banthi* is frequently made of rather fanciful shapes, and often there is added to the end of it a serrated iron disc which is useful for scraping the cocoanut from its shell. The combined implement is termed *kuruni*. A somewhat elaborate *kuruni* is shown in Plate XI, Fig. 12. Rough knives (*chhuri*) with straight blades are used for cutting goat's flesh, &c. In Patna I saw many straight knives and choppers, the whole knife, blade, handle and all being forged from one piece (Plate XI, Figs. 9 and 10). I noticed that the butchers instead of using these knives as a European would do frequently held the handle between the toes and thus converted the knife into an improvised *banthi*: it appears to come more natural to a native of Bengal to cut in this way just as it appears to come more natural for him to dig with a *koduli* rather than with a spade.

(*b*) *Water-vessels.*

In Behar and the upper parts of Bengal where water has to be drawn from wells, the manufacture of water-vessels from sheet iron is an industry of considerable magnitude. The vessels which are most commonly used for drawing from the wells are known as *dones* or *doles*. Two types of *dole* are known: the larger one (Plate XI, Fig. 13) may be described as a cylindrical vessel with a conical bottom. The pieces of sheet iron of which it is made are fastened together with rivets which stick out on the outer surface of the vessel like studs. Attached to the top edge of the *dole* are two rings to which a rope can be made fast. These *doles* are generally about 1 foot in diameter and 18 inches high. They are

of considerable weight and on account of their conical bottoms they at once fill when let down into the well. For this purpose they possess considerable advantage over the English pail or bucket which, having a flat bottom, is very apt to float on the surface of the water and to be filled only with difficulty. From an artistic point of view also the *dole* is very much to be preferred to the English bucket. A smaller type of *dole* (Plate XI, Fig. 14) generally about 8 inches diameter and 8 inches high may be likened in shape to an egg from which the pointed end has been cut away. This type of *dole* has rivets flush with the outer surface and is supplied with a handle somewhat like that of an English bucket. In the centre of this there is a swivel-ring to which the well-rope is attached. Besides the *doles* the *ghara*, *ghaila* or *gagra* is an iron water-vessel very commonly used (Plate XI, Fig. 15). The manufacture of a *ghara* has been already described in Chapter IV. These vessels may be called pitchers. They are in shape very similar to the earthenware or brass *gharas*. The iron *gharas* made in Bengal are almost all rivetted. In Behar many *gharas* may be found in which the joints are brazed, but these are said to come from Mirzapur. In connection with the drawing of water from wells, mention may be made of the *jhugra* which is a bundle of iron hooks so arranged that it bristles with hooks in all directions. This is tied to a rope and used for recovering water-vessels which may happen to have fallen into the well. The vessel is sure to be caught by one of the many hooks on the *jhugra*. A common form is shown in Plate XII, Fig. 8.

(*c*) *Personal.*

The razor (*khur*, *churra*, *khura*), the nail-cutter (*narun*), the receptacle for the black pomade used for blacking the eyes of children (*kánjal-latá*, *kajrowta*, *kajranta*) are iron articles used in the toilet. Razors are made and ground by most cutlers. They are of the same shape as the European article (not hollow-ground), but are generally very rough affairs. The oriental barber who is such an expert as to be able to shave a sleeping man without awakening him is not to be found in Bengal. The *napit* of this province is far inferior in skill to the ordinary English barber and cannot strop to a fine edge either his own country-made razor or one of good European make. The nails are generally pared and cleaned by the barber after the customer has been shaved. The *kajrowta* (Plate XII, Fig. 4) is a small spoon with a lid to the bowl and a hook at the end of the handle for convenience in hanging up the spoon. The black is made by putting a little oil in the spoon and heating over a lamp until it takes fire. This toilet accessory is invariably hung from the bottom of the bed in the lying-in chamber, so that the ointment may be at once applied to the eyes of the new-born infant.

Finger-rings and toe-rings (*angti*, *anguri*) made of iron are frequently worn by the poorer people. The blacksmith himself very frequently wears an iron finger-ring. The iron bracelet which is worn by all married women has already been mentioned (*vide* Chapter I). Necklaces partly made of iron may frequently be seen worn by men.

(*d*) *Miscellaneous.*

For cleaning the *hookah* an iron skewer is used; for handling the charcoal for the pipe, a small tong is used—frequently simply a few

inches of the steel binding from a bale bent into the shape of a tong. For cutting the betel-nut, a special instrument is used [*jánti, saratha* (Behar), *guacáti* (Orissa)]. This is in shape something like a nut-cracker, but instead of the broad crushing surfaces, there is on one side a sharp steel edge (Plate XII, Figs. 1, 2 and 3). Fairly good steel is required for this purpose as the betel-nut is very hard. The *jánti* is frequently to some extent ornamented and its shape may be fantastically varied. The native of Bengal is very fond of keeping birds (generally green parrots) and the bird's-cage (*pinjra, pijra*) is made not of wire but of strips, ¼ inch to ½ inch wide, cut from iron sheet. These strips are put together in much the same way as the wires in an English bird-cage. The result is a very clumsy looking affair (Plate XII, Fig. 5), which must be very much of an iron-barred dungeon for the unfortunate inmate. Such cages are largely made in Calcutta and Patna. Rat-traps built in the same substantial manner (Plate XII, Fig. 6) are more excusable. Perches for birds (*udda*) are very frequently seen in the hardware dealers' shops. They are generally hoop-like swinging perches and carry one or two dishes for water and seed. For locking doors, a *padlock* is generally used either in conjunction with staples driven into the door and door frame or with staples and bar or staples and chain. Many imported cheap padlocks (*tálá*) are used and many very rough articles are made by the native blacksmiths after the European pattern. In the neighbourhood of Patna, a somewhat fanciful form of padlock is manufactured (Plate XII, Fig. 7) and this type is very largely used in Patna city. In the morning a shop-keeper may be seen going to open his shop with something very like a screw-driver in his hand, which is the key of this kind of padlock.

III.—Tools and other Articles used in various Handicrafts and Professions.

The tools of the blacksmith have already been enumerated; those of the coppersmith, silversmith and goldsmith are similar, but smaller and lighter. The tools of the carpenter are the hammer (*hátaru*), the wood-cutting chisel (*rukhani*), the axe (*barsi*), the plane (*randa*), the saw (*ara, ari*), the drill (*bumar*), the screw-driver (*pechkas*). These are all much after the same pattern as the European articles. The drill is somewhat different, being worked by a kind of bow, the string of which passes once round the shaft of the drill. In building a hut or godown, the following iron articles are generally used:—nails (small—*kántá*; medium size—*parák*; large—*gazál*), staples, hooks, door-hinges (*kabjá*), bolts (*gazál*), door-bars, door-chains (*hánshkál*). The nails are of various shapes. In Behar the doors are frequently studded with nails with ornamental heads—star-shaped with hemispherical boss in centre. The door-hinges are invariably of the simplest pattern. In the construction of a boat a special kind of nail shaped  (*pátána*) is used for holding together and in place the planking of the hull. Large bolts are used for fastening together the keel and the ribs. Boat anchors (*nangar*) are generally of the shape of grappling irons. The anchor chain (*sikii, sikul*) completes the list of iron articles in an ordinary native boat. The mason uses an iron or steel implement for cutting and shaping bricks (*basuli*) and a trowel (*karni*). The *dursi* uses scissors (*kainchi*)

and needles made of steel. All the country-made scissors are evidently made after the pattern of the European article. The shop-keeper uses scales for weighing which generally have iron-pans and often iron beams; and even a small shop-keeper often keeps his money in a safe. Safes are made and repaired by the larger blacksmiths, but no doubt such safes are not particularly burglar-proof, their chief advantage lying in their weight, which prevents them from being carried bodily away and in their having thick iron plate walls which cannot easily be cut through. As a result of the so-called *Swadeshi* movement, there have started within the last few years several native firms for the manufacture of safes only, and some of these firms claim to manufacture safes equal to the best European articles. At the recent Industrial and Agricultural Exhibition, Calcutta, 1906-07, a native firm offered safes to stand any tests.

IV.—Weapons.

Enough has already been said about the manufacture of guns (*banduk*) at Monghyr. The number of guns manufactured in other parts of the province is negligible. Pistols are also manufactured by the gun-makers of Monghyr. These same mistris also manufacture sword-sticks which are in imitation of the European articles. The only part of Bengal in which at the present day anything of the nature of a sword or dagger of indigenous design is manufactured is the Darjeeling district. Here the Nepali *kāmi* manufactures *kukris* and *kataris* (Plate XII, Fig. 11), the former being by far the more common of the two. The *kukri* blade is generally about 1 foot long, though occasionally much longer blades are produced. The very characteristic shape of the blade is too well known to need description (Plate XII, Figs. 9 and 10). Probably also a few Lepchha knives (*bān*) (Plate XII, Fig. 12) are made in this district. In the bazaar of the town of Darjeeling many interesting knives, daggers, swords, &c., are exhibited by the curiosity dealers. These are always said to come from Tibet, Bhutan and Nepal. I made special enquiries to see if these articles actually did come from the places mentioned or if they were manufactured in the *bustis* around Darjeeling. It appears that they are not manufactured to any extent in the Darjeeling district. A few *kukris* which are said to come from Nepal are no doubt manufactured here, but that is about all. The explanation of this lies in the fact that the present Darjeeling district before it was taken over into Bengal was almost uninhabited, and all the Nepalis, Bhutias and Lepchhas to be found here are quite recent immigrants, and consider it natural to import articles from Nepal, Bhutan and Sikkim, rather than manufacture themselves. Mention has already been made of the special Nepal steel with which the best *kukris* are supposed to be made. Undoubtedly many *kukris* which can be bought in Darjeeling are made of very fine steel. The inferior quality *kukris* which can also be bought are probably all manufactured from European steel round about Darjeeling. The blade of an ordinary *kukri* is not ornamented. Sometimes a little ornamentation is chased on the blade, the design consisting of lines of small semicircles or dots or sinuous lines of which the constituent parts are circles, or patterns composed of straight lines (Plate XIII, Fig. 1). The straight line, the dot and the circle are the only constituents of the patterns of the Nepalese

kāmi. The patterns on an ornamented *kukri* may also be inlaid in brass. A very common inlaid pattern is apparently an image of the rising sun (Plate XIII, Fig. 2). I found a *kāmi* in Darjeeling who was able to make for me an ornamental *kukri*, equal to any from Nepal, but as a rule he had no demand for such articles and never thought of making them unless he was given a definite order.

Large knives for sacrificial purposes (*kanra, dao*) are manufactured in several places in South-East Bengal. These knives are kept in Hindu temples and are used for striking off the heads of sacrificial goats. The knives themselves are sacred. There are two types of such knives. The one is very similar to the ordinary bill-hook and is about 2 feet long. The other type (Plate XII, Fig. 15) has a very characteristic shape. It is identical in design with sacrificial knives manufactured in Assam and East Bengal. Probably the pattern originates in Assam or the very eastern districts of East Bengal, as there is some resemblance between this pattern and that of another type of sacrificial knife used in Assam and Bhutan. It is characteristic of the weapons of the Mongolian races, that the blades broaden at the end. Moreover, at the present time knives of this type appear to be more nicely made in these eastern districts than in Bengal. Hill Tippera and Sylhet are especially famous for them. In Bengal the best examples are made in Nadia and in Dubrajpur (Birbhum district). These knives are large and heavy, being often 3 feet long, with an average width of blade of 4 or 5 inches. They are ornamented with brass inlaying and with ordinary chasing. At the end of the blade an eye is frequently drawn and the handle is commonly ornamented with an elephant's head, the blade projecting from the mouth of the animal. The back of the blade is ornamented with strips of inlaid brass. In several examples from Dubrajpur the blades were ornamented with chased floral patterns (Plate XIII, Fig. 9).

Battle-axes are still manufactured in Chota Nagpur and Orissa. The most common forms are shown in Plate XII, Figs. 13 and 14, but many variations from this are found. These axes are now used as weapons of self-defence against wild animals and are carried by people going into jungles. They are also used to some extent as ordinary hatchets and for sacrificial purposes. These axes frequently bear some slight chased ornamentation, the pattern of which is invariably composed solely of straight lines, dots and portions of circles (Plate XIII, Fig. 5).

Bows and arrows are still frequently seen in the Sonthal Parganas, in Chota Nagpur and in Orissa. The arrow heads are of iron (Plate XII, Figs. 16, 17, and 18). The Sonthalis are said to be exceedingly good shots with these weapons; with which they do all their hunting. Even tigers and bear are hunted with the bow and arrow, and the arrow can be shot with such speed as to penetrate the thick hide of the wild pig. For birds and smaller game, a blunt-headed arrow is used (Plate XII, Fig. 20). Even fish and aquatic animals are killed with the bow, and Plate XII, Figs. 19 and 21, show the missiles used for this purpose. The three-pronged arrow is for *gariyals*, the fish-eating crocodiles. Spear-heads of iron are also made in Chota Nagpur and Orissa. The spear-heads are pointed and not blade-like. The round shields of Bengal

are scarcely made nowadays. It is not, however, so many years since steel or iron circular shields were made in the Sonthal Parganas and in Chota Nagpur. Plate XII, Fig. 22, shows such a shield. Again, it will be noticed that the constituent parts of the ornamental pattern are straight lines and parts of circles and that no other curve occurs. This, the absence of any but the simplest curve, appears to be a characteristic feature of ornamentation designed by any of the aboriginal tribes of Bengal.

CHAPTER VI.

A SHORT ACCOUNT OF THE MODERN INDUSTRY.

THE insignificance of the iron and steel industry of this province has already been emphasised; and from a study of the art of working in iron and steel as practised by the native blacksmith very little has been found in favour of this branch of the industry. The native blacksmith generally works only to order, and is thus frequently idle; even when at work the amount of material he can handle is very small; and the products of his handiwork are neither noted for their durability nor for their beauty. Nowadays many of the articles he produces are inferior imitations of European articles.

The only pleasing side of the industry in this province is what we may call the "modern industry," iron and steel work carried on in large works according to European methods. This industry is of course quite small, but it has developed very greatly within recent years, and its condition and future prospects appear very hopeful. And although there are only a few such, this province can boast engineering works which in size and equipment compare very favourably with all but the largest works in England; and the Bengal Iron and Steel Works produce pig-iron in blast furnaces of the most up-to-date pattern. In this branch of the industry Bengal compares very favourably indeed with the rest of India. This is the only province in which pig-iron is produced, and the importance of the private engineering firms can be judged from the fact that of a list of nine firms in the whole of India, which are considered by the Government of India of sufficient size and importance to be allowed to tender for Government work, seven are Bengal firms.

The following list gives the more important iron and steel and engineering works in the province:—

- The Bengal Iron and Steel Co.'s Works, Barakar.
- Messrs. Burn & Co.'s Engineering Works, Howrah.
- Messrs. Jessop & Co.'s Bridge Works and Foundry, Howrah.
- Messrs. Jessop & Co.'s Engineering Works, Calcutta.
- Messrs. Jessop & Co.'s Rolling-stock Works, Garden Reach, Calcutta.
- East Indian Railway Engineering Workshops, Jamalpur.
- East Indian Railway Workshops of the Carriage and Wagon Department, Lillooah.
- Eastern Bengal State Railway Engineering Workshops, Kanchrapara.
- Government Gun and Shell Factory, Cossipore and Ishapore.
- Government Rifle Factory, Ishapore.
- Messrs. J. H. King & Co.'s Engineering Works, Howrah.
- The Hooghly Docking and Engineering Co., Ld., Howrah.
- The British India Steam Navigation Co.'s Docks and Engineering Workshops, Howrah.
- The Ganges Engineering Works, Howrah.
- Messrs. Turner, Morrison & Co.'s Ship-building Yards, Shalimar.

Besides these, there are a large number of smaller firms, *e.g.*, Messrs. Butler & Co. of Muzaffarpur and various firms under native management in and near Calcutta. Some idea of the number of these smaller firms may be obtained from a directory. Messrs. Thacker, Spink & Co.'s Calcutta Directory for 1907 returns—

Boiler-makers	2
Cutlers	4
Electrical Engineers	20
Mechanical Engineers	20
Structural Engineers	16
Engineers and Contractors	87

The following table, giving figures to show the magnitude of some of the larger works, must be considered as only a very rough approximation. It may be taken as applying to the period 1905-06 : —

WORKS.	Number of men employed.	Amount of raw materials used per annum.	Value of products per annum.
		Rs.	Rs.
Bengal Iron & Steel Works, Barakar...	3,000	...	36,00,000
Messrs. Burn & Co., Ld., Works, Howrah.	4,500	26,00,000	40,00,000
Messrs. Jessop & Co.'s Works—			
Garden Reach	1,300	...	...
Calcutta	...	...	..
Howrah	...	...	...
East Indian Railway—			
Engineering Workshops, Jamalpur	10,000	...	54,00,000
Wagon Shops, Lillooah ...	3,500	...	...
Eastern Bengal State Railway Engineering works, Kanchrapara.	...	...	...
Government Gun and Shell Factory, Cossipore and Ishapore.	6,000	36,75,000	...
Government Rifle Factory, Ishapore ...	...	6,50,000	...
The Hooghly Docking and Engineering Co., Howrah.	200—1,000	2,50,000	5,50,000

These figures show 30,000 men employed in seven works only; the total number employed in iron and steel and engineering works may be roughly estimated as at least 40,000.

The following brief accounts of some of the more important works are written after a personal visit to the works concerned. I must here offer my best thanks for the facilities which were in all cases extended to me:—

The Bengal Iron and Steel Works, Barakar.

These works are situated on the grand chord line of the East Indian Railway, a few miles from Asansole. They consist essentially of blast furnaces and a foundry. There are three blast furnaces, which are all of the same type, with cup-and-cone arrangement for feeding and closing the mouth, and the hot blast is supplied by five tuyères to each furnace. The blast is heated by Cowper stoves, of which there are eight. At the time of my visit, two furnaces were in blast and two stoves were in blast and six in gas. The size of the furnaces may be judged from the production. When three furnaces are in blast, this amounts to 6,000 tons per month. The coke for the furnaces is at present largely obtained from Jheria, though it is seriously under consideration by the firm to make all their own coke so as to ensure uniformity of quality. The large percentage of ash in Indian coal and coke is one of the difficulties which beset the producer of pig-iron in this country. The ore is obtained over a considerable area in the Bengal coal-fields, and very different grade ores are obtained from the various workings. The ores all contain the iron in the form of Fe_2O_3; and some, *e.g.*, the Kalimati ores, are high grade and contain as much as 65 per cent. iron. The majority, however, contain a high percentage of silica, often as much as 20 per cent. With the present system of working, the various ores are mixed so as to feed the furnace with a material of constant proportions. The Company are, however, prepared to work with purer ore in one furnace so as to produce a hæmatite pig suitable for acid-hearth steel-making, if there is sufficient demand. The limestone used comes from Sutna.

The ordinary foundry pig produced has the following composition:—

(*Analyses kindly supplied by the General Manager of the Works.*)

	No. 1.	No. 2.	No. 3.	No. 4.
Si	3·40	3·00	2·75	2·40
Mn	1·40	1·50	1·75	1·80
P	1·20	1·30	1·40	1·45
S	0·02	0·03	0·04	0·04
C (graphitic)	3·45	3·20	3·00	2·90
C (combined) ...	0·23	0·26	0·30	0·40

which, the Company claim, shew that their pig compares favourably with the best English foundry pig.

The foundry which is close to the blast furnaces produces about 15,000 tons of castings per annum and is capable of making from 25,000 to 30,000 tons. The Barakar pig only is used for the foundries. The bulk of the castings are pipes and pot-sleepers, but at the time of my visit I saw a number of small and intricate castings being made also.

At Barakar there is also a steel-producing and rolling plant (two 25-ton basic open-hearth furnaces and rolling plant to correspond) which was put up and commenced work in 1904, but was closed down and is now lying idle. (A discussion on the general question of steel-production in Bengal will be found in Chapter VIII.)

A large number of the workers at Barakar are housed by the Company, and great care is taken that the dwellings shall be kept in a perfectly sanitary condition. Distilled water being produced in quantity in the

works is supplied to all. The Company's own medical officer systematically inspects the lines, and a thorough system of control is in vogue.

Messrs. Burn & Co.'s (Ld.) Works, Howrah.

These works are situated on the Howrah side of the Hooghly and have the advantage of a considerable length of river-front for ship-building and for taking in and despatching goods. They are also well connected with the railways. The works may for convenience be divided into four sections—(*a*) the foundry, turning, fitting and engine-shops; (*b*) the bridge and girder-shop; (*c*) the wagon-building yards; (*d*) the ship-building department. Besides these, there are also large store godowns for the storage not only of materials for construction, but also of goods which are sold by the Company as dealers.

The ship-building department is necessarily on the river front; the bridge-shop runs at right angles to the river front right away back from the river to the public road on the Howrah side. It is a very large shop, 1,200 feet in length, and is fitted up in the most modern fashion for systematically turning out large quantities of work It has overhead electric cranes, multiple electrically-driven drills and hydraulic and pneumatic rivetters. The wagon yards run parallel to the bridge-shop on the one side, and on the other side are the turning shops, fitting shops, foundry, etc. The whole works are conveniently fed by a system of rails running from the river-front.

At the time of my visit the works had on hand a considerable amount of bridge-work, 500 jute wagons for the Bengal-Nagpur Railway, a small ocean-going steamer being built under Lloyd's survey, a number of ferry boats for the Rangoon service, a floating waste-pipe for the steam dredger *Sandpiper* for the Calcutta Port Commissioners, the erection of a number of steam ferries also for the Port Commissioners, as well as a variety of work in the engine shops.

Messrs. Jessop & Co.'s (Ld.) Works.

The works at Howrah are essentially *bridge and roof works.* There is one long bridge-shop which comes up to the river-front at one end and is supplied with electric overhead cranes, multiple drills, hydraulic rivetters, etc. The foundry is also here, having been lately transferred from Calcutta. The chief work on hand at the time of my visit was for the new jetties and godowns for the Calcutta Port Commissioners—steel and reinforced concrete structures. There was also a large order under execution for mill-work—pillars, roof-work, shafting, pulley-drives, journals, etc.

The *Phœnix Works* at Calcutta are the engine-building shops. Here a number of small winding engines for the Bengal collieries were under construction. A number of jute presses were also being built.

In the *Rolling-stock Works* at Garden Reach all parts of a wagon are manufactured, except wheels, axles and axle-boxes. At the time of my visit they had on hand an order for 500 wagons for the East Indian Railway and 600 wagons for the Bengal-Nagpur Railway. The works were fitted with all the most modern appliances, *e.g.*, for rapid cutting of heavy steel

sections, for cutting plates, multiple punching, die-stamping, pneumatic rivetting, etc. In the case of the wagons for the East Indian Railway, the order for which was placed owing to emergency, the springs and draw-bars were being made, although the Railway Board had decided that these parts could not be made in this country and must be imported.

The Government Gun and Shell Factory, Cossipore and Ishapore.

The size of this factory can be judged from the large number of hands employed (6,000). At the time of my visit the factory was producing 50 18-pounder quick-firing field guns and 180,000 shells per annum. On account of the necessity of using very special steel for the construction of guns and shell, a steel-producing plant is an important part of the factory. There are at present two 10-ton acid open-hearth furnaces, and the material used for these furnaces is scrap-steel, hæmatite pig from Cumberland, and a very small quantity of ore. These furnaces can produce 40—60 tons per diem, which is a much larger quantity of steel than required by the factory itself in time of peace, and the Factory Superintendent is at present trying to find a market for the excess production The shell-making shops cover a very large area. The size of this branch is being very much increased and it is being transferred from Cossipore to Ishapore. The large steam-hammers and hydraulic presses are a feature of these shops. The making of guns has only recently been taken up again at Cossipore. In the shops devoted to gun and gun-carriage making, the work is of a highly specialised character requiring highly skilled workmen. The castings and forgings required are of a highly complicated character, and the subsequent machining requires not only exceptional and ingenious machine tools, but also tools capable of working to an exceptional degree of accuracy. The shops devoted to fuse and gauge-making are instructive examples of automatic shops.

Since the Boer War, it has been decided that the ordnance factories in India must be enlarged sufficiently to supply all the warlike stores required by the Indian Army, and consequently Cossipore and the Ishapore branch of the factory will be greatly enlarged.

Although the labour required in many parts of the factory must be highly skilled, yet practically all the workers have been entirely trained in the factory. The labour as recruited is generally quite untrained. A notable feature is the large proportion of Muhammadan workers. In the automatic tool shops the men earn 5½ annas per diem, whilst the highest trained mechanics can earn Re. 1-8 to Re. 1-12 per diem. The officers in charge of this factory claim that they have done a great deal for the iron and steel industry of the province in the way of training mechanics, who frequently leave to find employment with private firms. Most of the workers at the Ishapore Factory are housed in dwellings provided by the factory, and great care is taken that these quarters shall be clean and sanitary.

The Government Rifle Factory at Ishapore.

This factory is close to the Ishapore branch of the Government Gun and Shell Factory. It is scarcely yet in full working order, but

during the next year it is expected that 80,000 rifles will be manufactured here. A visit to this factory leads to an appreciation of the accuracy of the work required in a regulation rifle and to the conviction that the native of India, under proper supervision and guidance, is quite capable of doing even the highest class of work.

* *The Engineering Workshops of the East Indian Railway at Jamalpur.*

The workshops are equipped with all necessary accommodation and appliances for building locomotives and the manufacture of railway plant and material of all classes (except rails). The iron foundry turns out over 2,000 tons of castings, the steel foundry about 300 tons, and the rolling mills about 400 tons of iron and steel bars per month . . . . . The works cover 99 acres, of which 19 are roofed over.

* *The Rolling-stock Works of the East Indian Railway at Lillooah.*

The workshops and staff quarters cover an area of some 200 acres and about 3,500 men are employed in the construction and repair of rolling-stock.

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* Not visited. Accounts taken from East Indian Railway Time-Table, February 1907, pp. 108-109.

CHAPTER VII.

INSTRUCTION IN THE TECHNIQUE OF THE INDUSTRY.

VERY little has been done in the province in the way of imparting a knowledge of the technique of the iron and steel industry in professedly educational institutions. At the Civil Engineering College, Sibpur, there is a department of mechanical engineering with well equipped foundry, smithy and turning shops, and all the students as a matter of course pass through this department. The native students are of the *Babu* class and in practice it has resulted that the majority of the successful students of the College have obtained appointments in the Public Works Department of the Government and that few have taken up mechanical engineering as a career. This class of students are of too high a social standing to work as mechanics; they have as a rule no money to start concerns of their own; European firms will not employ them as foremen, because Europeans are considered much more satisfactory in handling labour, and up to the present the number of native engineering firms who might employ them in this way is exceedingly limited. Naturally, therefore, the majority of the successful students are attracted to the Public Works Department of the Government which *can* find them employment.

At the Civil Engineering College there are a limited number of Europeans and Eurasians taking the same courses as the native students, and some of these after passing satisfactorily through the College obtain employment as foremen in the European firms.

There are also at Sibpur a few artisan pupils who belong to the mistri class. These come at an early age and pick up their education in the shops. They are given a small salary, Rs. 3 to Rs. 5 per mensem, to compensate their parents for their labour, and as they grow older they obtain employment as mistris in some of the Calcutta engineering works.

In the following institutions which are affiliated to the Civil Engineering College, Sibpur, the students receive a course of manual training which includes a certain amount of work in iron and steel :—

The Dacca Engineering College.	Dacca Collegiate School.
The Behar School of Engineering.	Rangpur Technical School.
Patna Collegiate School.	Pabna ditto.
Burdwan Technical School.	Comilla ditto.
Midnapore ditto.	Barisal ditto.
Ranchi ditto.	Rampur Boalia School (B classes).
Bhagalpur School (B classes).	Mymensingh School (ditto).

Victoria School, Kurseong.

All the students in these schools are of the *Babu* class (except at the Victoria School, Kurseong, which is reserved for Europeans and Eurasians), and are even less likely than the students of the Sibpur College to find a career in the mechanical branch of the Engineering profession.

With the growth of the *Swadeshi* movement, there is some possibility of these students starting small concerns of their own or managing small concerns financed by small native capitalists or of finding employment in larger native concerns if such are started, but even the keen advocate of

the *Swadeshi* movement does not seem willing to put his money into the industrial development of the country, and such native concerns are not springing up as one might have expected.

The Reformatory Schools of Alipore and Hazaribagh teach blacksmith's work and cutlery.

It does not appear, however, that for the artisan classes employed in the iron and steel industry any more efficient education is required than they naturally acquire in the factories and workshops in which they are employed. The work of the mechanics in these shops is satisfactory, and with proper training in this practical manner, the native can perform satisfactorily the most difficult mechanic's work. And the higher class of employés in the Engineering firms under European control will always be obtained from Europe. So that for the proper development of the modern iron and steel industry in the province it does not appear that any further direct educational measures are necessary.

CHAPTER VIII.

PROSPECTS OF THE IRON AND STEEL INDUSTRY IN BENGAL.

THE development of the modern iron and steel industry on the factory system would be undoubtedly to the advantage of the province, especially if it were made imperative on the factory management to provide sufficient thoroughly sanitary house accomodation for their workers. The province would gain, as a larger number of the inhabitants would be occupied in a thoroughly profitable manner, instead of wasting their time either from want of work or want of knowledge and training, and whether the capital by which the factories were financed were European or Bengali, it would not affect the result, viz., that the province would be richer by the market value of the additional work done. The province being richer would be less likely to suffer from famine. The development of the iron and steel industry could not be objected to on any similar ground to that on which complaints against the jute mills are sometimes based, viz., that owing to the high price which can be obtained for jute, large areas previously under rice are now given over to jute cultivation, consequently the rice crop is diminished and the price of foodstuff is raised. There would no doubt be some difficulty in inducing any very large number of the people of the province to adopt the factory system and leave the villages of their birth and the land to which they are attached. But if hand in hand with the development of the factory system the native could be taught improved methods of agriculture, many men could be spared from the land for factory work without any decrease in the crop production. There would probably be still further difficulty in inducing the workers to live contentedly in clean and sanitary quarters supplied by the factory management. But such a system would do a great deal to improve the health and physique of the race. And this taken in conjunction with the mental development which would also result must be considered as a very strong argument in favour of the factory system. There is, however, some objection to the congregation of too many factories around one centre such as Calcutta and Howrah, as in the neighbourhood of a large city it would be difficult to compel the workers to live in factory quarters, and unless this could be done, the result of the congregation of factories around the cities would simply be that a considerable proportion of the population would move from the country districts to the native quarters of the cities where the sanitation is even worse than in the villages. For the sake of the working classes it would be preferable for the factories to be more or less distributed along the lines of railway and for new factories to be started away from already existing native cities so that the housing of the workers could be properly tackled at the start in each case.

It will of course be always necessary for a certain number of blacksmiths to work in their present style in the small villages to make repairs in the agricultural implements of the raiyat population, to shoe the cattle and so on; and probably the number of workers of this kind which will always be required is not much less than the present total of native blacksmiths. There appears, however, no reason why the number should increase,

nor does it appear desirable that this should occur. Agricultural implements, such as kodalis, sickles, bill-hooks, etc., can be made more economically and of better quality in factories than on the "cottage" system, and with increase of railway communication, the distribution of factory-made articles of this class will be effected more and more cheaply, so that the scope of the village blacksmith will in time be reduced down to repair work only.

The development and future prospects of the industry on the factory system depend on a large number of different factors, *e.g.*, on the advantage which the local industry can count on securing over the European trade on account of freight costs, on the growth of the local demand, and especially in this country on the support of Government. In discussing the matter we must consider that the local industry is in competition with European rivals which have slowly developed, and as the result of long experience have in many directions come very near perfection. There are many specialised branches of the trade into which the local firms can scarcely hope to enter, *e.g.*, the manufacture of engines of high power, of electrical machinery or of boilers. The demand for such articles in this country is limited and their manufacture requires a large special plant and special experience. Again in such a trade as the manufacture of nails, nuts, bolts, rivets, washers, etc., the local firms cannot compete. This class of goods can be shipped out for much the same cost as the raw materials required for their manufacture, and the local industry is in this case not at all helped by the shipping tariff.

The direction in which it appears there is most chance of success is in heavy work, such as bridge and mill-work, etc., for here a high degree of specialisation is not necessary, a developing country has considerable requirements in this direction, and the shipping rates are a considerable help. The assistance derived from the shipping rates comes in this way:—The rate per ton increases enormously with the weight of the smallest parcels into which the goods can be packed. Thus quoting from shipping rates kindly supplied to me by Messrs. Burn & Co.:—

January 1906—Machinery—Glasgow—Birkenhead to Calcutta.

		s.	d.		
Under 1 ton lifts	...	13	6	per ton weight or measurement.	
1 ton and under 2 ton lifts	...	15	0	ditto	ditto.
2 ditto 3 ditto	...	20	0	ditto	ditto.
3 ditto 5 ditto	...	28	4	ditto	dtto.
5 ditto 8 ditto	...	42	6	ditto	ditto.
8 ditto 10 ditto	...	57	6	ditto	ditto.
10 ditto 15 ditto	...	85	0	ditto	ditto.
15 ditto 20 ditto	...	125	0	ditto	ditto.

Local firms manufacturing this class of goods will import their raw materials at a much cheaper rate than the finished article can be shipped into the country.

The recent freight-war in the shipping trade from Europe to Calcutta has been to the general disadvantage of the iron and steel industry of

the province. The rates from Glasgow or Liverpool to Calcutta dropped in 1905 to less than half the figures ruling in 1900. Thus:—

January 1900—Glasgow to Calcutta.

Iron and steel, 20*s.* per ton and 10 per cent. primage.

April 1905.

Iron and steel, 9*s.* 6*d.* per ton.

with a corresponding drop for other classes.

This of course means that the area over which the Bengal firms can compete at an advantage due to tariff becomes more limited, for during the same period the railway tariffs have remained practically unchanged.

In this country the local industry is specially dependent on the Government, as with the Public Works and almost all the railways directly under its control, it is by far the largest consumer of all classes of iron and steel goods. This can be seen at a glance from Tables V and VI, Chapter II, which show that Government takes about as much as the total private trade. Government has gradually given to the local firms a larger share of its orders, though the protracted deliberation before each concession has been made—and this only after the earnest protestation of the firms concerned—has produced in many quarters the feeling that Government has not really at heart the welfare of such local firms, but would prefer to continue as of old to place all its orders in England through the Stores Department of the India Office. The Government Resolutions giving a share of Government orders to the local trade were issued in the years 1883 and 1898; in 1891 a Resolution was issued which was regarded in many quarters as a drawingback from the policy inaugurated in 1883, but since 1898 the policy adopted has been more liberal. In 1900 an extension of the concession of 1898 was made which was much appreciated in certain quarters. Since that date local firms have been allowed to compete for a certain fraction of the wagon-supply for Government and guaranteed railways.

The problems of pig-iron and steel production must be considered separately. There is still a very large quantity of pig-iron imported into the Province for foundry purposes, and the local firm producing foundry pig could legitimately hope to secure the greater portion of this trade. There is, however, among the local engineering firms an objection to the Barakar pig, on the ground that fine and intricate castings cannot be made with any certainty in this iron. On the other hand the Barakar firm itself makes fine and intricate castings with ease from its own iron, and the management is quite willing to show the representative of any engineering firm over the foundry to see such castings being actually made there; and it also maintained that the analysis of Barakar pig shows it to be quite suitable for the finest class of foundry work.

For the demand for foundry pig there is a limit: if, however, the manufacture of steel once had a proper start in this country, the limit of the demand for pig-iron would then be enormously extended. The production of steel in Bengal already has a history. A small Siemens acid-lined furnace was first erected at Cossipore in 1892 under the direction of Major-General (then Captain) Mahon, R.A., and since that date steel has

been successfully manufactured at Cossipore. Recently the productive capacity has been increased by the erection of two 10-ton furnaces of the same acid open-hearth type, and now the factory is capable of turning out from 40 to 60 tons of steel per day. This amount is, as a matter of fact, not at present produced, as the factory itself does not always require this quantity, and arrangements have not yet been made for the disposal of the excess. At Jamalpur also a certain amount of steel is produced by the acid open-hearth process. This process cannot, however, be considered as the proper one for the thorough development of the iron and steel industry of the country. What is required is a steel-making process, using country-made pig as the chief material; and owing to the quality of the average ores of Bengal, the average pig produced is not sufficiently pure for use in the acid-hearth furnace. The basic open-hearth type is undoubtedly the furnace required for the production of high class steel in large quantity in this province, as by this process the country-made pig can be used as the chief material for the furnace charge and the steel can be made systematically and certainly with a composition lying between very narrow limits. The Barakar works attempted the manufacture of steel by this process in 1904 putting down a plant capable of producing 20,000 tons per annum, but after the loss of more than £50,000, the experiment was stopped. There appears in this case to have been initial difficulties especially in getting suitable foremen from Europe for the work, but the General Manager of the works explains the failure of the experiment as largely due to its not receiving the expected support from the Government. He says:—

"In 1901 our Home Board opened negotiations with the India Office with proposals to put down a steel plant to make 20,000 tons per annum of basic steel provided that quality of steel would be accepted and support be given by Government in the disposal of the product of the plant. It was expected that the bulk of the work which would be turned out at the steel works would be rails, that being the largest requirement of the Government of India, but the advisers of the India Office were opposed to large section rails being accepted if made of basic steel, and we were therefore limited to metre-gauge rails and under. Subject to the steel produced being of suitable quality, Government promised substantial support to the undertaking and encouraged the Company to put down the plant. A subsidy of £1,500 was paid to us, but a rebate of Rs. 3 per ton had to be given to Government on all steel purchased up to the equivalent of the subsidy.

"A plant to make 20,000 tons per annum was accordingly laid down, and operations were commenced at the end of 1904. An excellent quality of steel was made of which early samples were sent to Sibpur and Jamalpur workshops (East Indian Railway) to be tested, and in each case was most favourably reported upon. But although our steel was made to the best home specifications and was actually passed and accepted on a par with such, the support given to us by Government was so meagre that to find an outlet for our production we were compelled to go into a line of work, *viz.*, miscellaneous small merchant sections, which was unsuitable for many reasons and at once brought us into competition with foreign 'dumped' steel. During the period that the mills were running, 136 different sections in all were rolled.

"We had expected that, looking to the large quantity of rails annually imported into India, we could safely reckon on getting orders for the major part of the output of the steel works in the shape of rails of suitable sections to allow of the mills being kept on one section for a reasonable length of time. We did not get a single order for rails during the whole time the steel works were working! Instead

we received orders from Government for about 600 tons of steel in all, from first to last, and to roll off the orders nearly 70 charges of rolls had to be made, and our cost of executing such orders was out of all proportion to their value."

The great advantage to the country which would result from the proper development of steel production cannot be too strongly emphasised. At present the engineering firms of the province import practically all their raw material, certainly all their wrought-iron and steel, and thus the country pays shipping tariff on all its iron and steel work, whether it is executed by local firms or not. The establishment of the manufacture of steel on a proper footing would of course prevent all this. The whole of the iron and steel work required by the province might come from iron ore found in the province itself and available at a much cheaper rate than in Europe. It could be converted into pig-iron in local blast furnaces, and subsequently into steel in local steel furnaces, giving a large additional field for labour, and saving for the country all the money now lost on shipping tariff. In fact, the production of steel from country pig appears to be *the* advance which is now required in the local industry above all others. This would give a satisfactory basis to the industry, and the different branches could then develop with a much greater feeling of security.

APPENDIX.

SOURCES FROM WHICH INFORMATION HAS BEEN OBTAINED.

I.—Personal investigations in and near Calcutta and Howrah, including visits to the works of Messrs. Burn & Co., Ld., Messrs. Jessop & Co., Ld., Messrs. Martin & Co., Messrs. J. H. King & Co., and the Government factories at Cossipore and Ishapore.

II.—Tour in the province, including visits to Hooghly, Burdwan, Barakar, Monghyr, Bhagalpur, Dumka, Suri, Dubrajpur, Hetampur, Murshidabad, Patna, Darjeeling.

III.—Reports of District Officers.

IV.—Information especially communicated by W. Steele, Esq., of Messrs. Burn & Co., Ld., W. MacFarlane, Esq., General Manager of the Bengal Iron and Steel Co., Ld., and Major Bell, Superintendent, Government Gun and Shell Factory, Cossipore, for which I tender my best thanks.

V.—The Economic Section of the Indian Museum, Calcutta, (*a*) the collections, (*b*) the files, which were kindly placed at my disposal by the Superintendent, J. H. Burkill, Esq.; the Archæological Gallery, Indian Museum.

VI.—The following books and papers:—

Monograph on Indian Arms and Armour by B. H. Baden Powell, C.I.E. (No. 53 of the Journal of Indian Art, vol. VI).

Indian and Oriental Armour by Right Hon'ble Lord Egerton of Tatton.

The Antiquities of Orissa by Rajendralal Mitra.

Buddha Gaya by Rajendralal Mitra.

The Stupa of Barhut by A. Cunningham.

Tree and Serpent Worship by J. Fergusson.

The Cave Temples of India by Fergusson and Burgess.

The Musnud of Murshidabad by P. C. Majumdar.

Murray's Hand-book to India, Burma and Ceylon.

Wilson's Translation of the Rig Veda.

The Brhat Sanhita, translated by Kern. Journal Royal Asiatic Society, N. S. VI, p. 81, *et seq.*

The History, Antiquities, Topography and Statistics of Eastern India, compiled from Survey Reports by Dr. Francis Buchanan, 1807–1813.

Kittoe.	Journal Asiatic Society of Bengal,	vol. VIII,	p. 144.
Babington.	Ditto	ditto,	vol. XII, p. 164
Welby Jackson.	Ditto	ditto,	vol. XIV, p. 754.
Dr. Oldham.	Ditto	ditto,	vol. XXIII, p. 279.

Report by Dr. Oldham in "Selections from the Records of the Bengal Government," vol. VIII, 1853.

Report by Dr. J. Shortt in "Selections from the Records of the Bengal Government," vol. XXIII, p. 184.

Geology of Darjeeling District by F. R. Mallet (Memoirs Geological Survey of India, vol. XI, 1874).

The Raijarh and Hinjir Coal Field by V. Ball (Records of the Geological Survey of India, vol. VIII, 1875).

Geology of the Rajmahal Hills by V. Ball (Mem. G. S. I., vol. XIII, pt. 2, p. 87, 1877).

Dr. Oldham. Mem. G. S. I., vol. I, 1859.

A Manual of the Geology of India, vol. III, Economic Geology by V. Ball.

Chota Nagpur by F. B. Bradley-Birt.
Ethnology of India by R. G. Latham.
History of India by Hon'ble Mountstuart Elphinstone.
Manu's Code, translated by Sir W. Jones.
Indian Agriculture by R. Wallace.
The Farm Manual by A. C. Williams and D. J. Meagher.
Census of Bengal, 1901.
Reports on Trade carried by Rail and River in Bengal.
Annual Statements of the Trade and Navigation of British India.
Various Parliamentary Papers (United Kingdom).
Public Works Department Code from 1883 up to date.
Financial Review of Operations of Ordnance Factories in India, 1905-06.
East Indian Railway Time-Table, February 1907.

EXPLANATION OF PLATES.

PLATE I.—Ancient weapons copied from sculptures at Udayagiri, Barhut, Buddha Gaya and Amaravati.

Fig. 1.—Sword in sheath, worn by door-keeper from the Rani Nur Rock Cut Temple, Udayagiri Hill, Orissa. Original sculpture in Archæological Gallery, Indian Museum, Calcutta. Drawing in "Antiquities of Orissa" by R. L. Mitra. Plate XXIV, Fig. 94.

Fig. 2.—Sword in hand of a warrior from frieze in Rani Nur Rock Cut Temple. Cast in Archæological Gallery, Indian Museum, Calcutta. Photograph in "Cave Temples of India" by Fergusson and Burgess. Plate I.

Fig. 3.—Sword from same frieze as Fig. 2.

Fig. 4.—Sword in sheath worn by warrior. From Barhut. Cast in Archæological Gallery, Indian Museum, Calcutta. Photograph in "Stupa of Barhut" by Cunningham. Plate XXXII, Fig. 1.

Fig. 5.—Sword in hand of Bhairava from Buddha Gaya. Drawing in "Buddha Gaya" by R. L. Mitra. Plate XXVI, Fig. 2.

Fig. 6.—Sword in hand of Savita from Buddha Gaya. Drawing in "Buddha Gaya." Plate XXXI, Fig. 1.

Fig. 7.—Sword from hand of a Goddess at Buddha Gaya. *Op cit.* Plate XXXI, Fig. 3.

Fig. 8.—From same statue as Fig. 7.

Fig. 9.—Sword in hand of Bhairava from Buddha Gaya. *Op cit.* Plate XXXI, Fig 4.

Fig. 10.—Sword in hand of Vagisvari Devi from the temple of Vagisvari Devi, Buddha Gaya. *Op cit.* Plate XXXII, Fig. 2.

Fig. 11.—Shield from same frieze as Fig. 2.

Fig. 12.—From same statue as Fig. 5.

Fig. 13.—Discus from same statue as Fig. 5.

Fig. 14.—Battle Axe. In statue of Maya Devi from Buddha Gaya now in Indian Museum, Calcutta. *Op cit.* Plate XXIX.

Fig. 15.—From same statue as Figs. 7 and 8. Battle Axe.

Fig. 16.—Bow taken from sculpture on a pillar at Buddha Gaya. Cast of pillar in Archæological Gallery, Indian Museum, Calcutta. Photograph in "Buddha Gaya." Plate L.

Figs. 1a to 9a.—All from sculptures in the Great Outer Rail of Amravati Tope, and illustrated in "Tree and Serpent Worship" by J. Fergusson.

Fig. 1a.—Spear. *Op cit.* Plate LIX. Photograph.

Fig. 2a.—Sword. *Op cit.* Plate LX. Photograph

Fig. 3a.—Sword or dagger. *Op cit.* Plate LXI. Photograph.

Fig. 4a.—Bow. *Op cit.* Plate LXI. Photograph.

Fig. 5a.—*Op cit.* Plate LXI. Photograph.

Fig 6a.—Sword or dagger. *Op cit.* Plate LXVI. Lithograph.

Fig. 7a.—Spear. *Op cit.* Plate LXVI. Lithograph.

Fig. 8a.—Javelin. *Op cit.* Plate LXVI. Lithograph.

Fig. 9a.—Shield. *Op cit.* Plate LXIX Lithograph.

PLATE II.—Ancient weapons from sculptures at Bhuvanesvara (copied from Antiquities of Orissa by Rajendralal Mitra. Plates XXIX, XXIII and XX).

Fig. 1.—Lancet-headed dagger from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 184.

Fig. 2.—Dao or bill-hook from Bhuvanesvara. *Op cit.* Plate XXIX, Fig 200.

Fig. 3.—Straight sword in scabbard, common in Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 183.

Fig. 4.—Double-bladed sword from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 178.

Fig. 5.—Double-bladed sword from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 179.

Fig. 6.—Broad straight sword (broken) from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 180.

Fig. 7.—Jagged sword, straight-blade and handle from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 181.

Fig. 8.—Straight sword, lancet-head, from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 182.

Fig. 9.—Nepalese knife or kukri from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 186.

Fig. 10.—Deer-head handled dagger from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 185.

Fig. 11.—Ganesa's battle-axe from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 187.

Fig. 12.—Battle-axe broad blade from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 188.

Fig. 13.—Curved bladed battle-axe from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 189.

Fig. 14.—Discus from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 199.

Fig. 15.—Short club from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 201.

Fig. 16.—Long club from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 202.

Fig. 17.—Triangular dagger from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 205.

Fig. 18.—Bow from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 203.

Fig. 19.—Warrior clad in coat of mail and helmet from Amravati. *Op cit.* Plate XXIII, Fig. 91.

Fig. 20.—Club from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 206.

Fig. 21.—Short javelin from Bhuvanesvara. *Op cit.* Plate XXIX, Fig. 204.

Fig. 22.—Copied from Plate XX, No. 65e. Cast of same in Archæological Gallery, Indian Museum, Calcutta. Short sword or dagger.

Fig. 23.—Copied from Plate XX, No. 65b. Cast of same in Archæological Gallery, Indian Museum, Calcutta, described by R. L. Mitra as a Khāṇḍá or broad Indian sacrificial sword.

PLATE III—

Fig. 1.—Pageant shield from Kanarak, copied from Antiquities of Orissa. Plate XXX, Fig. 218.

Fig. 2.—Two spears in the armoury of the Palace of Murshidabad—

(*a*) Peshro bullum, a famous spear supposed to have been made before the Christian era, and taken by the Muhammadans on conquering the country.

(*b*) Spear probably made A. D. 1700—1750, ornamented with design in low relief of elephant, tiger and leopard.

PLATE IV—

Fig. 1.—"The Bachawali Tope," an old gun lying at Murshidabad and supposed to have been made A. D. 1200—1400.

Fig. 2.—"The Jahan Kosha," an old gun lying at Murshidabad and made in 1637 A. D.

PLATE V.—Ancient weapons from the armouries of the Palaces of Murshidabad and Burdwan—

Fig. 1.—Pata, a spear used in Muhammadan festival processions (Murshidabad Palace).

Fig. 2.—Saang, a kind of spear (Murshidabad Palace).

Fig. 3.—An old gun made at Kamarpara near Burdwan and used in a battle against the English in 1761 (Burdwan Palace).

Fig. 4.—Sword made at Bhagalpur (Murshidabad Palace).

Fig. 5.—Tega Burdwani, an executioner's sword made at Burdwan (Murshidabad Palace).

Figs. 6, 7, 8, 9, 11, 12 and 13.—Spears in the armoury at Murshidabad.

Fig. 10.—A spear known as *bichhu* (Burdwan Palace).

PLATE VI.—Iron smelting by the Native process near Dumka in the Sonthal Parganas—

Fig. 1.—Photograph of the furnace in blast showing method of working the bellows, etc.

Fig. 2.—Diagrammatic bird's-eye view of the furnace.

PLATE VII—

Fig. 1.—Blacksmith's shop at Monghyr, showing simplest form of hearth and bellows. The blacksmith is a typical *Lohar*.

Fig. 2.—Blacksmith's shop at Dubrajpur, district Birbhum, showing more elaborate hearth.

PLATE VIII.—Gun-making in Monghyr—

Fig. 1.—Boring a barrel.

Fig. 2.—Showing various stages in the making of a gun—

(*a*) The hammered-out-strips used for making a barrel with the simple-twist marking.

(*b*) A bundle of alternate iron and steel strips to be hammered out into a strip.

(*c*) Twisted strips for making damascened barrels.

(*d*) An assortment of borers and handle.

PLATE IX—

Fig. 1.—A cutler's shop at Burdwan, showing grinding-wheel and method of driving this. The cutler is a typical *Kamar*.

Fig. 2.—The tools used in sheet-metal work, *e.g.*, for making a *ghara*—

(1) A completed *ghara*.

(2) Iron club fixed in ground used as a rest for tightening rivets.

(3) Curved anvil for hammering sheet into shape.

(4) A completed *ghara* in vertical section to show structure of neck.

(5) and (6) Wooden mallets for hammering sheet into shape.

(7) and (8) Iron hammers.

(9) Iron hammers for work inside the *ghara*.

(10) Pincers or pliers.

(11) Chisel-pointed compass for describing circles on the *ghara*.

(12) and (13) Small iron clubs held in the hand for hammering down a rivet from the inside of the *ghara*.

PLATE X.—Agricultural implements, commonly made by the village blacksmith—

Fig. 1.—Iron tip for plough share—usual type.

Fig. 2.— Ditto seen from edge.

Fig. 3.— Ditto another type.

Fig. 4.—Iron hooks for yoke of bullock-cart.

Fig. 5.—Hub of bullock-cart wheel, showing parts made of iron (shaded).

Figs. 6 and 7.—*Kodalis*.

Fig. 8.—Pick-axe with two points, *gainti*.

Fig. 9.—One-pointed pick, *kanka*.

Figs. 10, 11, 12 and 13.—Various forms of *kachia*, sickle-shaped implement with teeth.

Figs. 14 and 15.—*Hassua*, sickle-shaped implement without teeth.

Fig. 16.—*Garaser*, an implement for chopping straw.

Figs. 17 (*a*) and 17 (*b*).—An axe which can be used in two ways—*kuráli* or *tanga*.

Fig. 18.—The ordinary axe, *kuráli* or *tanga*.

Fig. 19.—An implement for cutting grass, *kurpa*.
Fig. 20.—A form of *kurpa* for weeding.
Fig. 21.—*Nironeo*, a weeding tool.
Figs. 22, 23, 24, 25, 26, 27, 28, 29 and 30.—Various forms of the bill-hook or *dáo*.

PLATE XI.—Cooking utensils, commonly made by the village blacksmith—

Figs. 1, 2 and 3.—Different forms of portable fire-grate or *ungati*.
Fig. 4.—Portable oven, *tesal*.
Fig. 5.—*Tawa*, for baking bread.
Fig. 6.—Large spoon, *kulchhul*, used for cooking rice.
Fig. 7.—Stirrer used in cooking, *khanti*.
Fig. 8.—*Jhánjhárá*, perforated spoon for lifting sweetmeats from the frying-pan.
Figs. 9 and 10.—Knives for cutting goats' flesh, etc., *chhuri*.
Fig. 11.—Implement for cutting vegetables and fish, *banthi*.
Fig. 12.— Ditto ornamental, with cocoanut scraper, *kuruni*.
Figs. 13 and 14.—*Doles*, vessels for taking water from the well.
Fig. 15.—*Ghara* or *gagra*, water-pitcher of sheet-iron.

PLATE XII.—Weapons and miscellaneous articles prepared by the blacksmith—

Figs. 1, 2 and 3.—Betelnut cutter, *jánti*.
Fig. 4.—*Kajrowta*, small spoon with lid, for preparing and keeping black ointment for eyes of children.
Fig. 5.—Bird-cage, *pinjra*.
Fig. 6.—Rat-trap.
Fig. 7.—An ingenious padlock, *tálá*.
Fig. 8.—*Jhugra*, a bundle of hooks, used to recover water-vessels which have dropped into wells.
Figs. 9 and 10.—*Kukris*—Fig. 9, especially large and ornamented.
Fig. 11.—*Katari*, a weapon made in Darjeeling.
Fig. 12—The Lepchha knife or *bān*.
Figs. 13 and 14.—Battle-axes.
Fig. 15.—Sacrificial knife (very large), *khanra*.
Figs. 16, 17 and 18.—Arrows.
Fig. 19.—A three-pronged arrow used for catching gariyal.
Fig. 20.—Club-headed arrow for hitting birds.
Fig. 21.—Arrow for catching fish.
Fig. 22.—Circular shield of hammered steel, *Sonthál*, copied from The Journal of Indian Art. Vol. VI, Plate 84, Fig. 11.

PLATE XIII—Ornamental designs executed on steel weapons by Bengal blacksmiths—

Fig. 1.—Ornamentation on the large *kukri*, shown in Plate XII, Fig. 9 (chased).
Figs. 2, 3 and 4.—Brass inlaid designs on a small *kukri* made by a Darjeeling *kāmi*.
Fig. 5.—Chased ornamentation on a sacrificial axe.
Figs. 7 and 8.—Designs on old sacrificial knives kept in temples on the estate of the Raja of Hetampur.
Fig. 9.—Ornamentation on a sacrificial knife recently made by a blacksmith in Dubrajpur, district Birbhum.

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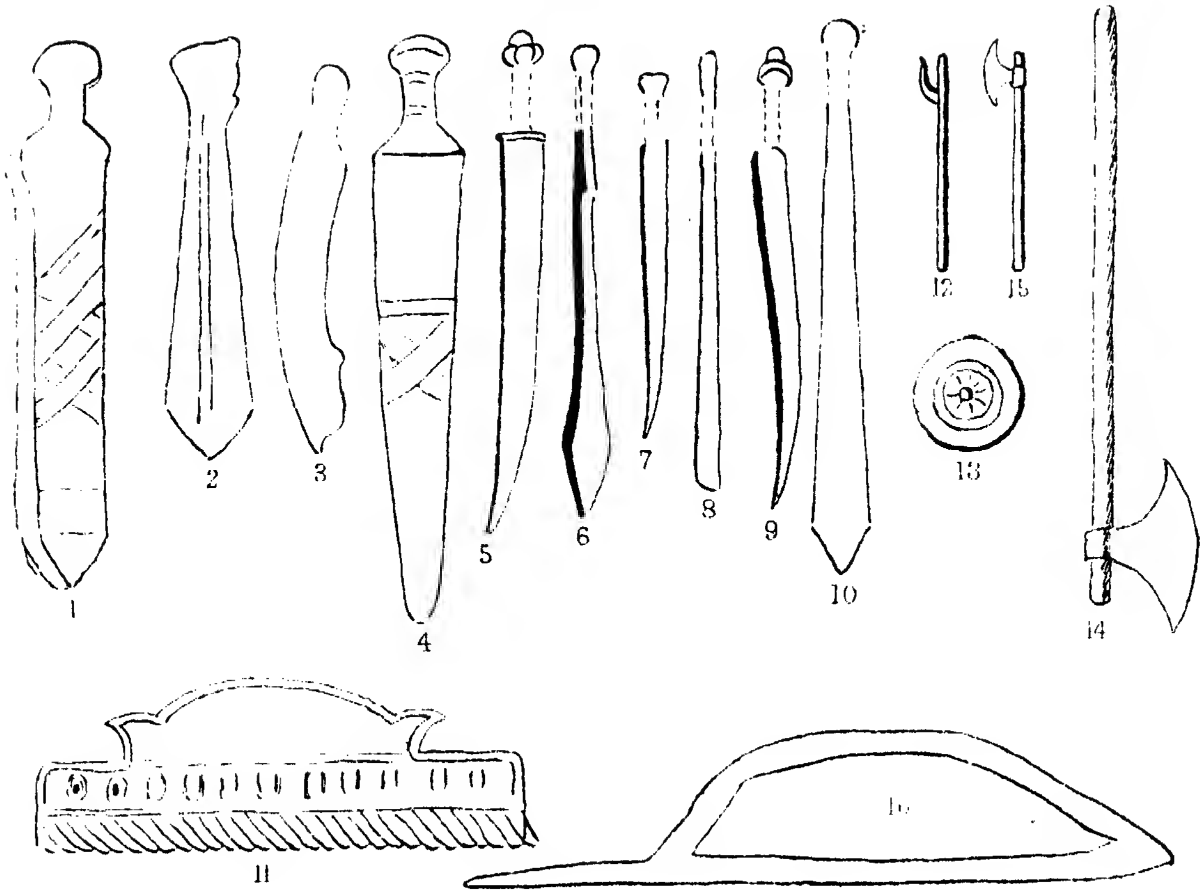
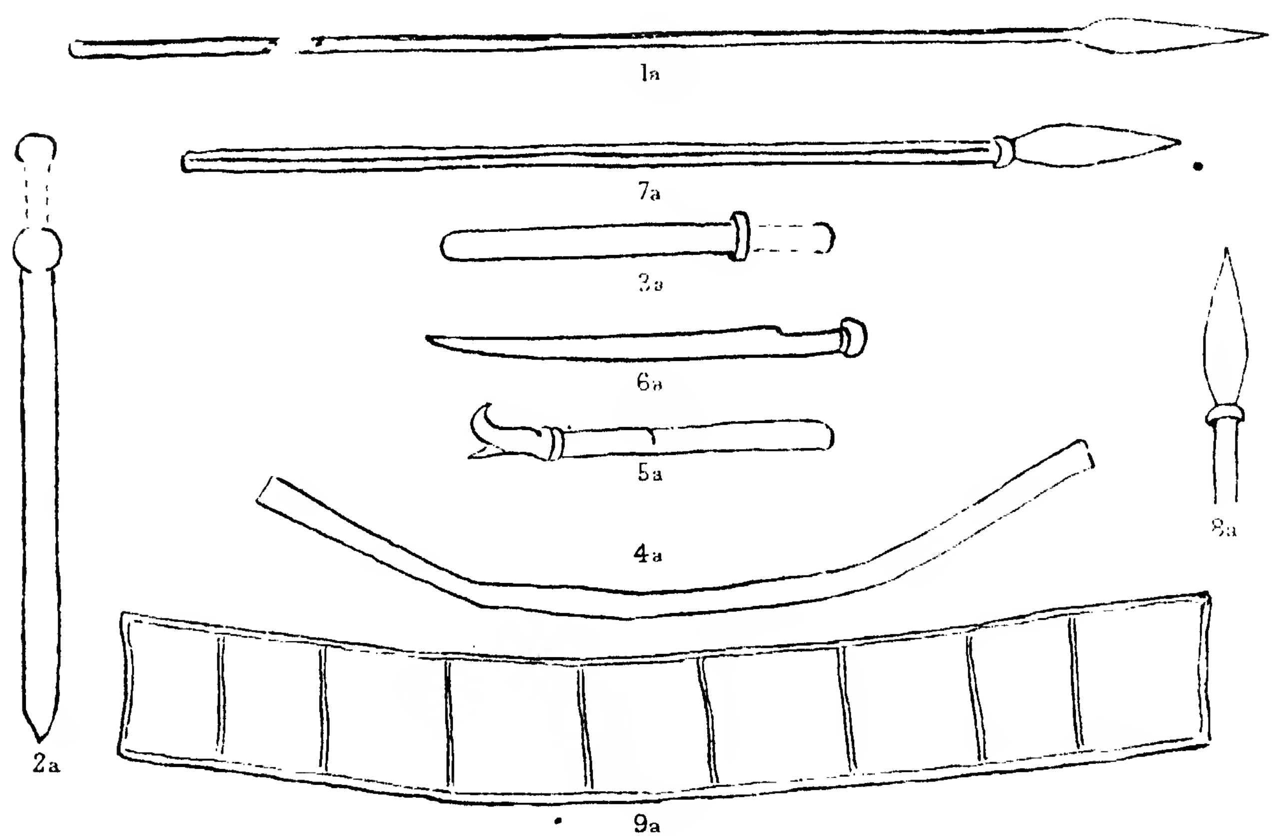
WEAPONS OF ANCIENT BENGAL

ABOUT 150 B.C.



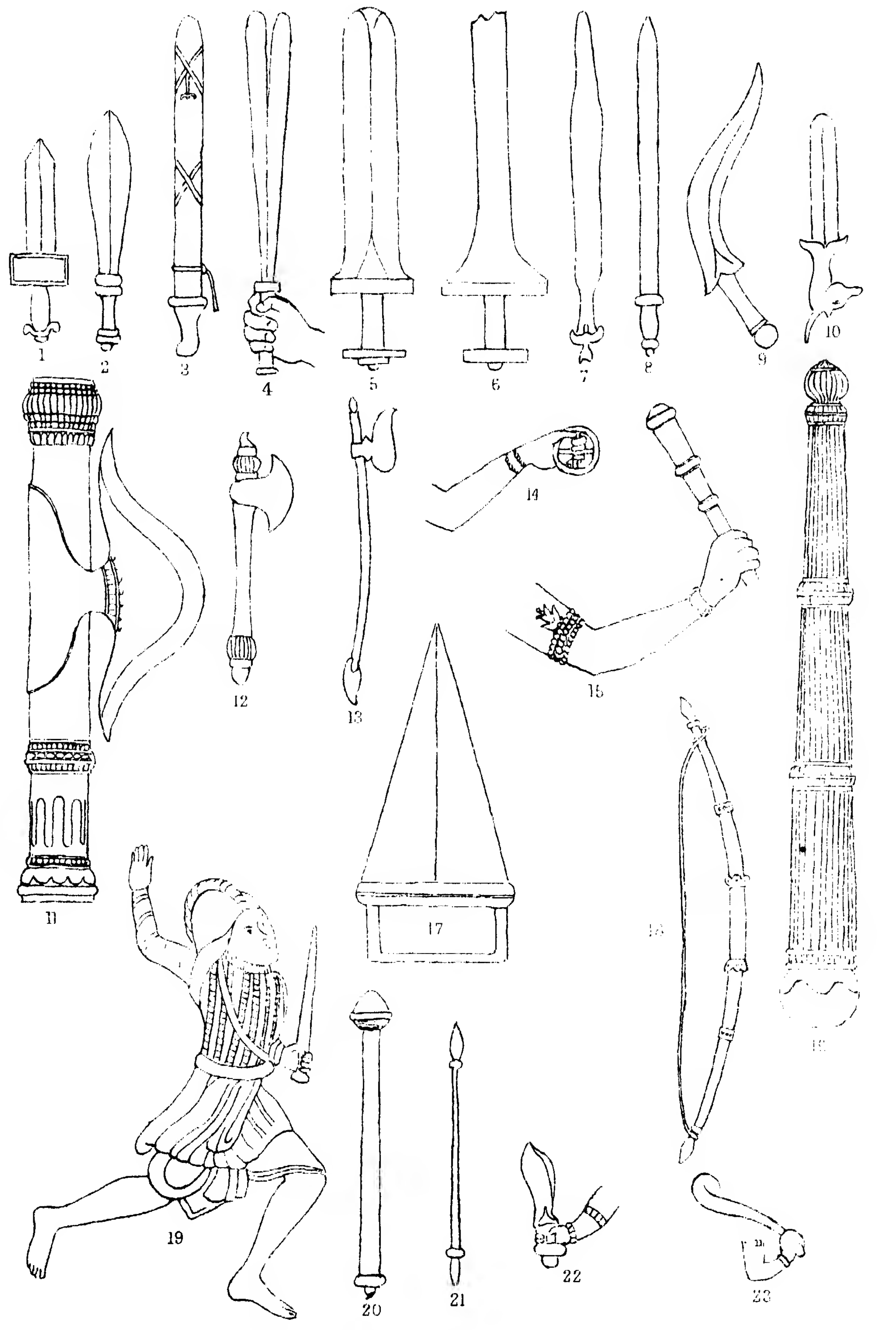
300–400 A.D.



Scale 1 Inch = 1 Foot

WEAPONS OF ANCIENT BENGAL

ABOUT 650 A.D.



Copied from Antiquities of Orissa by R. L. Mitra -- Scale not specified.

No. 437 E. Under Secy. Govt., Bengal — Jan. 08 — 00

Litho. B. I. O., Calcutta

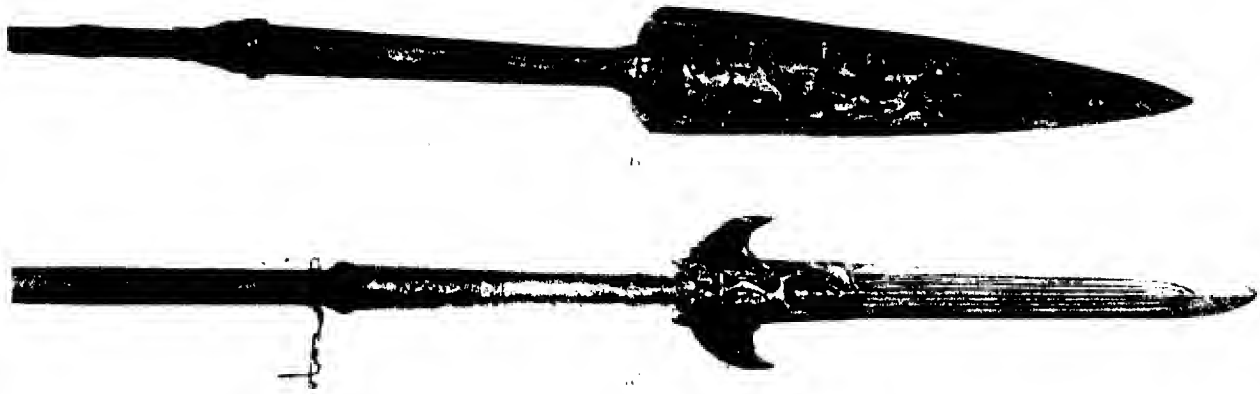
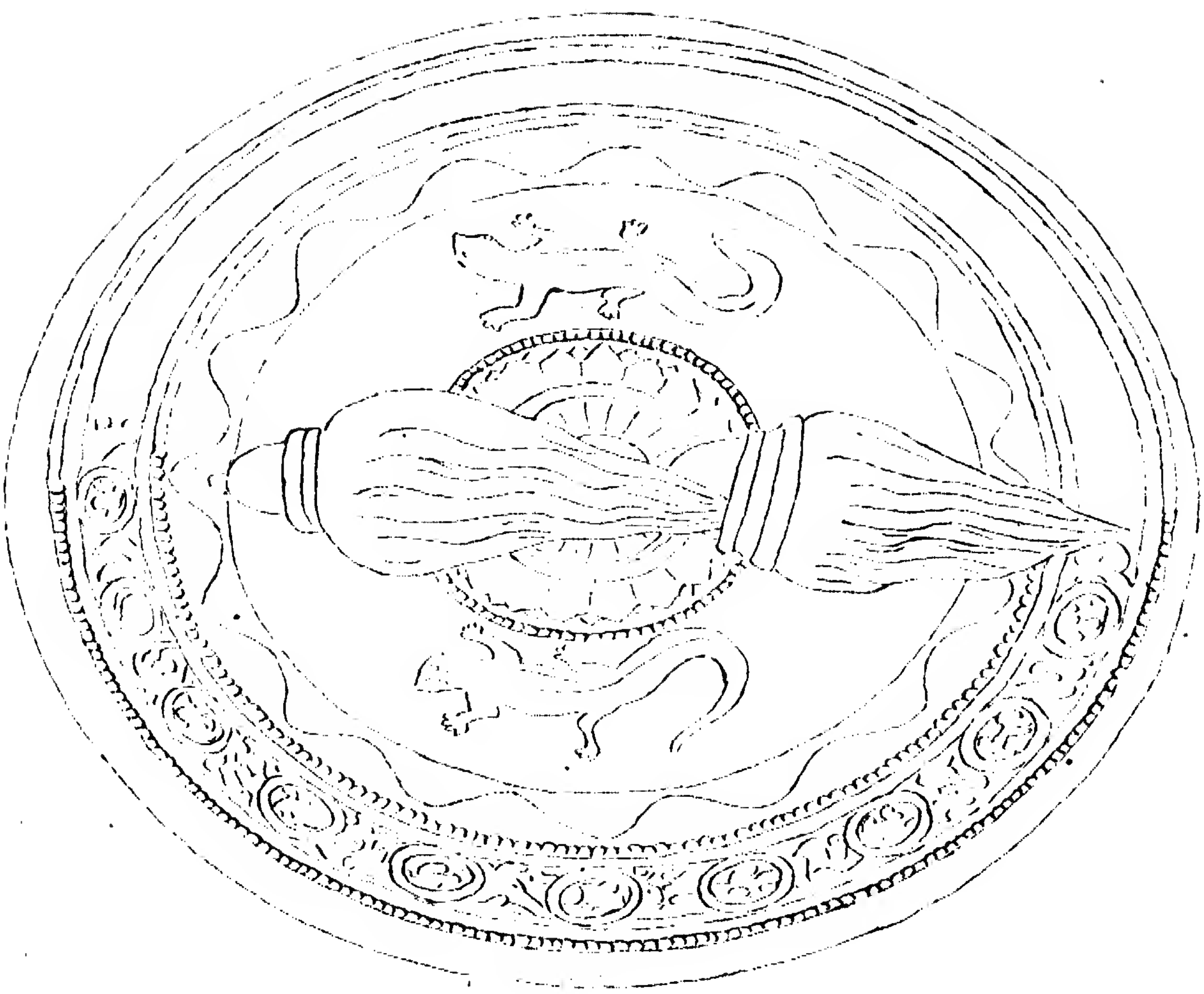


Fig. 2.

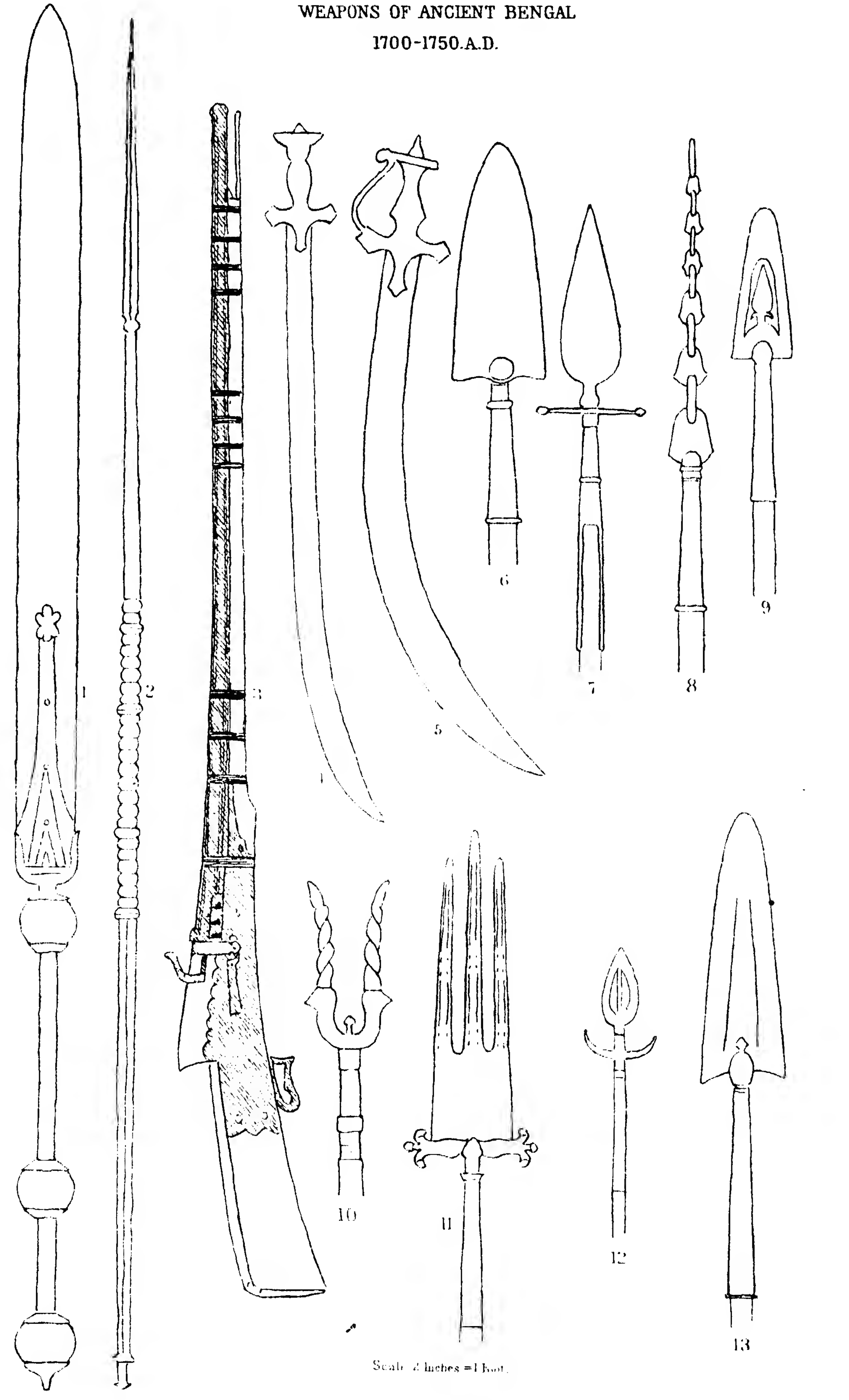


Photogravure.
Survey of India Offices, Calcutta, February, 190[illegible]

Fig. 1. THE BACHAWALI TOPE, 1200-1400 A.D.

Fig. 2. JAHAN KOSHA, 1637 A.D.

WEAPONS OF ANCIENT BENGAL
1700-1750 A.D.



Scale 2 Inches = 1 Foot.

Fig. 1. IRON-SMELTING IN THE SONTHAL PARGANAS.

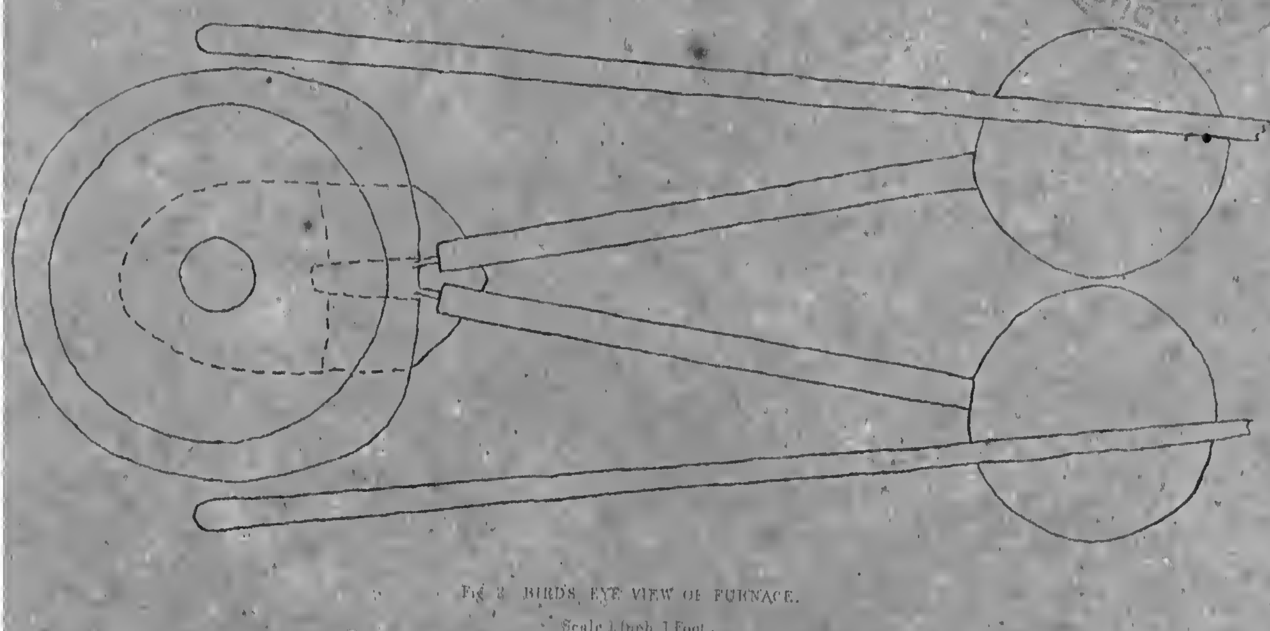


Fig. 2. BIRD'S EYE VIEW OF FURNACE.

Scale 1 Inch 1 Foot.

Photogravure

Survey of India Offices Calcutta, February 1908.

PLATE VII

Fig. 1.

Fig. 2.

Photogravure.

Survey of India Offices Calcutta, February, 1908

Fig. 1. GUN MAKING IN MONGHYR.

a c b d

Fig. 2.

Photogravure.

Survey of India Offices, Calcutta, February, 1908.

PLATE IX

Fig. 1.

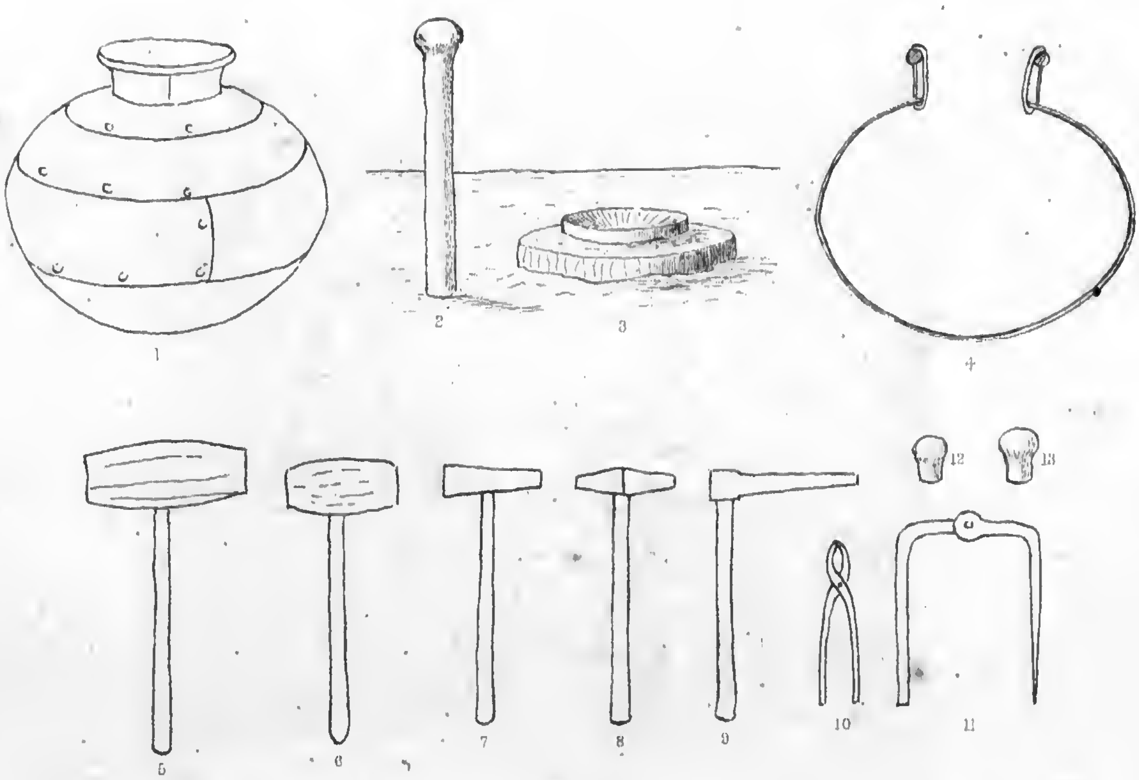


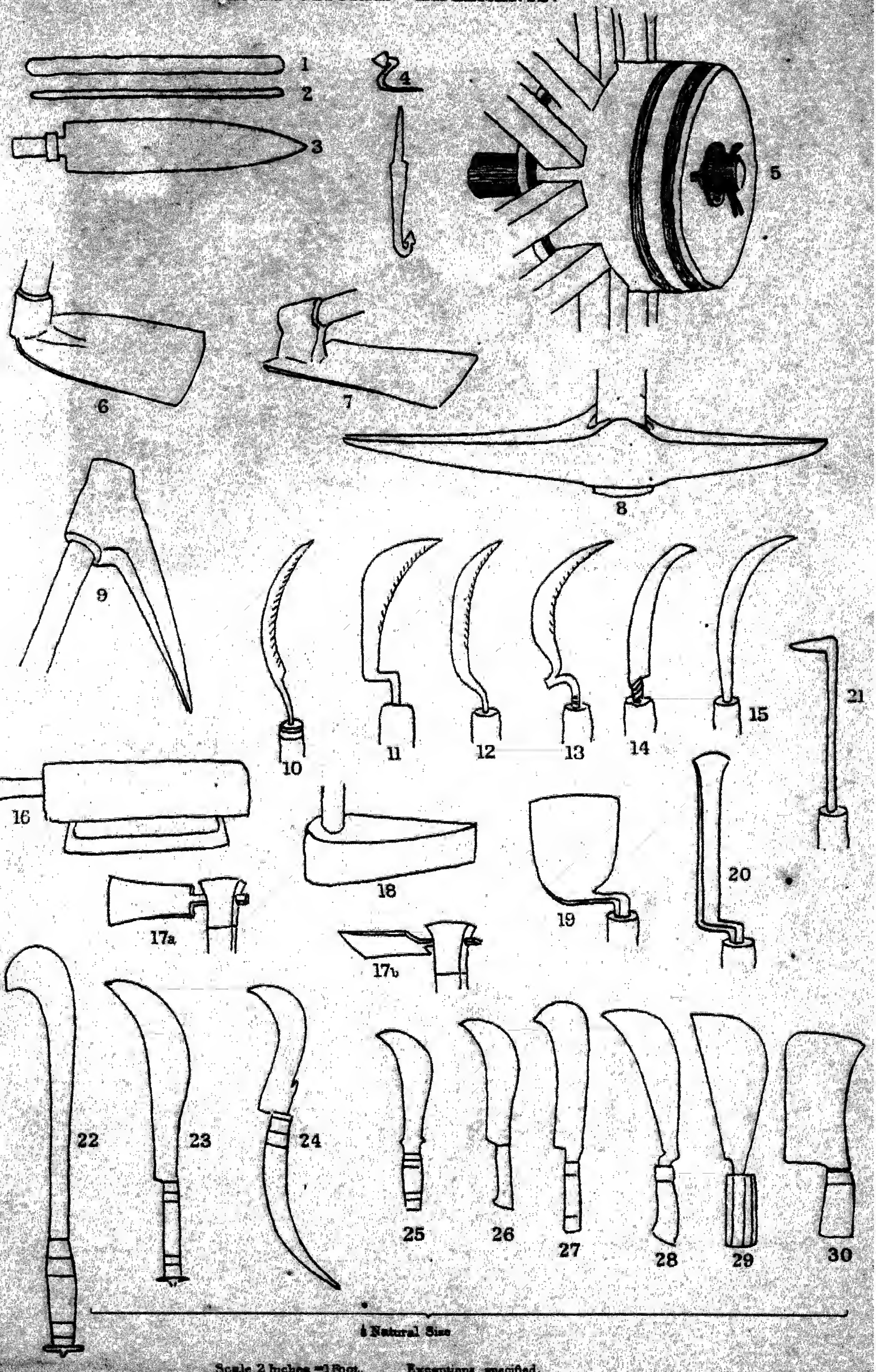
Fig. 2.

Scale 2 Inches=1 Foot.

Photogravure

Survey of India Offices, Calcutta, February 1908.

AGRICULTURAL IMPLEMENTS.



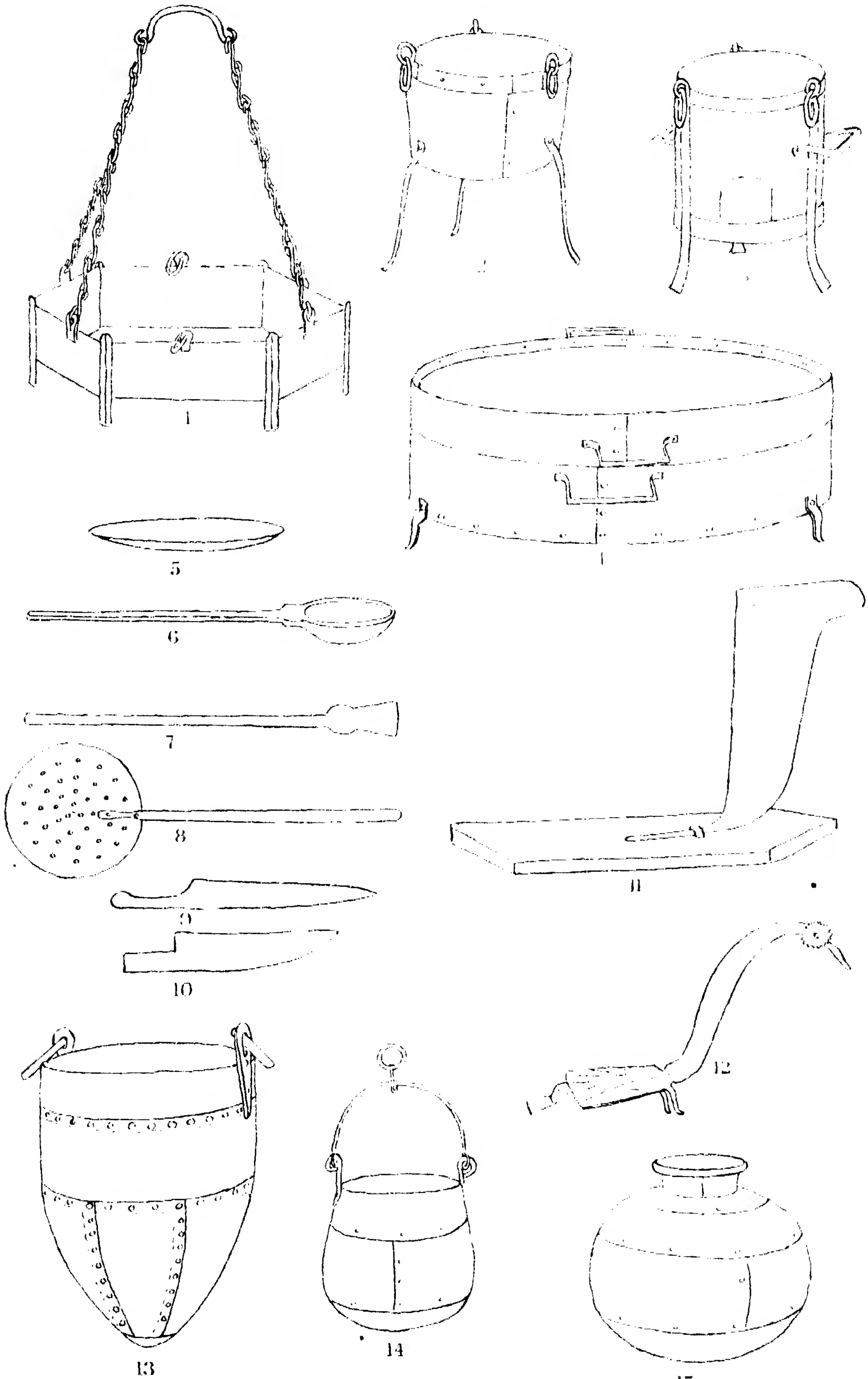
⅙ Natural Size

Scale 2 Inches = 1 Foot. Exceptions specified.

No. [illegible], Under Secy., Govt., Bengal.—Jan 06—000 Helio., S. I. O., Calcutta

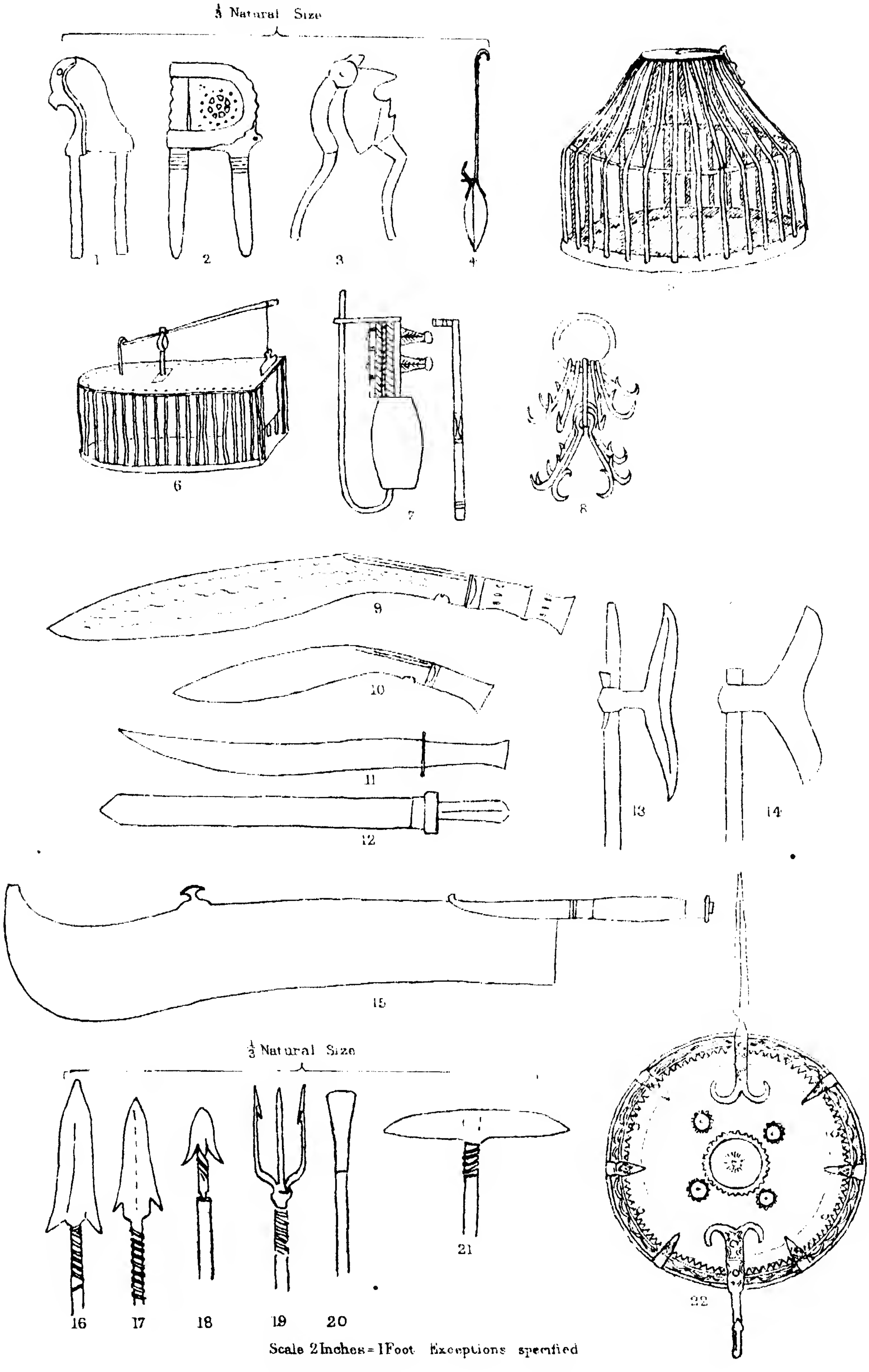
PLATE XI.

COOKING UTENSILS.



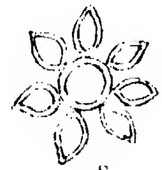
Scale 2 Inches 1 Foot

WEAPONS AND MISCELLANEOUS ARTICLES.



Scale 2 Inches = 1 Foot. Exceptions specified

ORNAMENTAL DESIGNS ON STEEL



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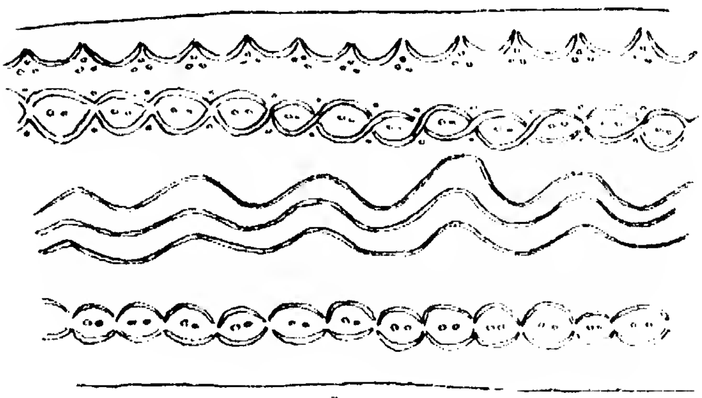

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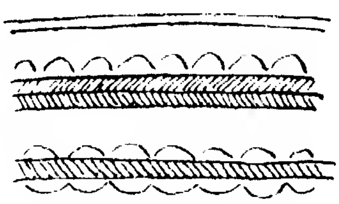

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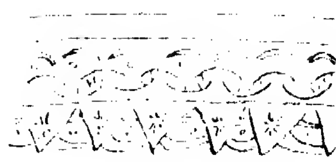

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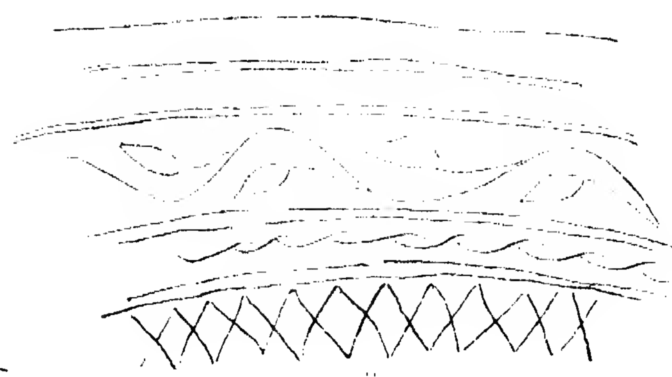

7

8

9

Natural Size